EDITORIAL

'DOLLAR OIL' the dream of the producer, has now practically become a reality. The latest prices are $0.98 per barrel at the well for oil under 18 gravity, $0.99 for 18 gravity, and $1 or more for 19 gravity and lighter.

THE railroads have asked the Interstate Commerce Commission and the various State public-utility commissions for an increase of freight rates of 15%. For over two years rates have remained practically the same. In the meantime the cost of almost every kind of material used by the railroads has increased considerably, in many cases more than doubled. Wages have also increased, particularly as a result of the Adamson Law. It is true that most of the railroads have enjoyed increased business, especially as regards freight, but this same increase of business has called for increased facilities, and for the purchase of large quantities of high-priced material. Most of these increased facilities must be provided by the issuance of new securities. With the present heavy demands on capital, the only way to make railroad securities regain their popularity with the investing public is to insure a reasonable return on the amount invested. The sum to be realized from the proposed increased rates, while large in the aggregate, when divided among the entire community will be comparatively small, and even this amount will be balanced in part by the more efficient service that the railroads will then be capable of rendering to the public. The railroads are doing everything in their power to assist the Government in war-measures, and they should be permitted rates that will allow a fair return on the investment.

ENGINEERS, and other civilians expert in any special line, will find abundant opportunity for the exercise of their abilities in helping to win the War. The four national engineering societies embracing more than thirty thousand trained men in the various professions have sent to their members elaborate questionnaire blanks designed to disclose for the benefit of the Government whom to call for services of a special nature. The Council of National Defense, in co-operation with the Quartermasters' Department of the Army, has enlisted the services of a number of men prominent in engineering construction for the building of the sixteen army cantonments in which the men called by draft will be housed during the period of their training. To design, construct, and equip within three months sixteen cities, complete in every detail, for an aggregate population of 500,000 men is a task calling for the highest order of executive and technical ability. It is obvious that the regulations of peace times must go by the board in an emergency such as this. The element of cost immediately becomes subordinate to the element of time. The usual custom providing for advertising bids thirty days in advance would involve a waste of time almost criminal, in view of the present emergency. The prime requisite is to deliver the goods, and deliver them quick. Due cognizance was taken of such contracting firms as had at their disposal an adequate organization, experience in the handling of large enterprises, and a reputation for fulfilling their contracts. The work was turned over to them as quickly as plans and specifications could be prepared and they are at it, hammer and tongs. Naturally there were some corns stepped upon; allegations of unfairness were made by local interests which had not been given a chance to obtain even a part of the work. This question must not be regarded as a local matter, but rather as one that effects the Nation as a whole. Time is the element, the one element, and the course that was taken provided for getting the desired results in the shortest possible time. There was no intention to slight anybody; in the meantime, there will be more than enough work to go around before many weeks have elapsed.

Newspaper Editorials and a Recent Dam-Failure

It is proverbial that discussion of engineering projects in the non-technical press is based on little or no real information. In another column appears a letter from Mr. Edwin Duryea regarding the recent failure of the Echo Lake dam in the high Sierras and the comment made upon it by a San Francisco daily. The peculiar and somewhat amusing part about the latter's discussion of the failure is that while the principles stated are sound and the conclusions correct, neither of these have much to do with the case in point, and there is great danger of the general public assuming, after reading the article, that unsafe dams are being designed and built every day.

Now the main offices of the company owning the dam are at Stockton, and it would have cost just thirty cents and a few minutes' time to have telephoned there and obtained all the facts given in Mr. Duryea's letter, or at least to be referred to Mr. Duryea himself for this information. And this is the weakness of most newspaper editorials of the present day. They are written with excellent intentions but little effort is made to base them upon facts. We are free to admit that the matter appearing in the news columns of a daily paper must, or at least should, be printed sub-

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stantially as it comes from the wire. But editorials even in a daily paper should be based on accurate information. That they frequently are not is probably the principal reason why the average reader pays little or no attention to them.

Student-Engineers and the War

Under-graduate engineering students find themselves in a quandary with respect to the War situation. Stirred by patriotic impulses, their first thought is to join the Army or Navy. We are inclined to question the wisdom of this move. The need for men below the age of twenty-one is not yet manifest. When it is, will be time enough. This question should be viewed carefully, intelligently, with the aim of achieving the country's greatest good, and not as a personal matter. An engineering student in his freshman, sophomore, or junior year, in fact any under-graduate below twenty-one years of age can serve his country better by completing his courses and then joining that branch of the Army or Navy for which he is best qualified, rather than serving in the ranks now and giving little return on his educational capital. The percentage of college-trained men is none too large, and the man who has had the inestimable advantage of a university education is a resource to be carefully conserved.

The old days, when the comanding general on a jet black charger led his men into battle have gone forever. This is the day of the engineer, the technical expert, the mathematician. He delves in range-finders, plotting boards, the energy of high explosives. He operates railroads, motor-truck trains, radio-telegraph and searchlight outfits. Everywhere there are highly technical details.

There are many engineers available, and the chances are that before long there will be at least two jobs for every one of them. Every officer in the Army or Navy must be something of an engineer, and most of them must be more than engineers, they must also be tacticians, and more important still, natural leaders of men. Under-graduate engineering students must keep their eye on the main issue, that is, to win this War. The more intelligent our preparation, the more quickly will we achieve this object. When the universities have given them all they could, then will the student be ready to undergo special training for the higher military problems. A half-baked schooling in the fundamentals is but an indifferent foundation upon which to construct an officer in a modern army. Note the wisdom of the draft law. It is a *selective* draft, whereby the selection is to be made by the older and wiser heads of only such men as can be taken with a minimum disturbance to business.

Every real American must take an active part in carrying the War through to a successful conclusion. In order that this may be achieved in the quickest possible time, all of us must not merely profess, but do, and do efficiently that which will contribute to our success. Not the least important feature in our individual activities is to select carefully such work as will take the utmost advantage of our training and experience. The man who conducts his business economically and well creates wealth, permits his employees to be self-supporting, provides a margin with which to pay taxes, and does his bit. The place for the young men is in the field. The place for the older men is at home, to work as they never worked before, to provide means for paying the bills, and preserve the commercial fabric of the Nation, that we may be prepared to meet the commercial war that will follow Armageddon.

Report on Mineral Resources for National Defence Council

The Department of the Interior has issued the following:

When asked about the mineral situation, Secretary of the Interior Lane said:

"In war time a new point of view must be had in order to grasp the situation. The great production of gold and silver in the United States, except from the financial point of view, is unimportant. But the 5000 ounces of platinum now reclaimed at the Government mints will make, by the 'contact' process, hundreds of thousands of pounds of concentrated sulphuric acid, which can all go into high combustible explosives.

"Let us begin with explosives. Speaking broadly, concentrated sulphuric acid, the famous H_2SO_4 of college memory, and nitric acid, are the two chief and vital elements necessary in explosive manufacture. We shall need about 6,000,000 tons of sulphuric acid this year. This acid is not a pleasant thing to transport, so in peace times it is generally used close to its point of production. We have two great natural beds of sulphur, but they are in the extreme southern part of the United States, with the result that in peace times we ordinarily import about 1,000,000 tons of iron pyrites, containing about 45% of sulphur, and roast it out. In time of need we could secure sufficient from our own beds, but with concentrated sulphuric acid the case is different. This acid is obtained from the fumes of lead and zinc smelters by the 'contact' process, which requires platinum in order to oxidize the gases. The machinery is expensive and takes time to install, but an ample supply can be assured if sufficient platinum is available.

"Nitric acid, made from nitrates, is the other necessary basic material from which high explosives are made. The United States contains practically no nitrates, nor does any other country except Chile. From Chile we import in peace times about 500,000 tons a year, of which about 40% is used for fertilizer and 40% for explosives. But the atmosphere around us contains nitrogen in limitless quantities, and Congress has voted $20,000,000 for the construction of a plant for its fixation. The situation and character of this plant now is being determined, so that in a comparatively short time we shall be equipped in this respect for the enemy in time of war and for added agricultural production in time of peace."

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REVIEW OF THE MONTH

WARS nowadays are fought by the whole people. The efficiency of this Nation as a war machine will depend upon our realization of this fact. The brunt of the fighting from a physical standpoint is borne by the Army and Navy. The responsibility for supplying the forces in the field with whatever they need and, at the same time, preserving as nearly intact as possible the commercial fabric of the Nation rests upon those who stay at home. With these problems we must deal, and the sooner we realize our responsibilities and meet them, the more quickly the War will be brought to a successful conclusion. The trade channels of peace times, will, in many cases, be diverted into new and unaccustomed courses. Business of some sorts will be diminished, perhaps temporarily discontinued, while, to offset such occurrences, new forms of activity will be created, and others will be intensified. The need for the basic products of the ground, foods, chemicals, and metals will be greater than ever. The only changes will come in their fabrication into new and, to us, unaccustomed forms. The American people are said to be adaptable to a great degree. Now is the time to prove it. To the man who may have made a living as a purveyor of choice perfumes before the War, and finds his occupation gone, there will be countless other forms of activity that will contribute directly to our success. All cannot be heroes, all cannot help to carry the Flag to the gates of Berlin, but every man Jack of us can 'do his bit' by increasing our output, curbing waste, eliminating personal extravagances, great or small, saving money and investing in Government bonds and supporting the American Red Cross.

IT is reported that the Liberty Loan has been oversubscribed 52%. The draft of our young men was effected with clock-like precision, and almost entirely without disorder. Here lies the answer to Potsdam of a peace-loving Nation, a Nation that loves peace so well as to be willing to fight for it. These are stirring times; the responsibilities placed upon this generation are enormous. We are now being subjected to the acid test that will prove our metal, base?—never, but rather as worthy descendants of the men of 1776, 1861, one-thousand fine.

ENGINEERS are taking a prominent part in war activities of all kinds. While there are military reasons for withholding detailed information, we know that some of our engineers are already in France, and that others are helping to rehabilitate the railroads of Russia. The nine regiments of engineers who are to assist in the reconstruction of the French railroads will soon be on their way to the front. Many other engineers are at the training camps. The Naval Consulting Board is composed of engineers, and they are also largely represented on the Council of National Defense. Here also we may feel reasonably sure that they are doing a great deal more than is permitted to find its way into the papers. Finally, Mr. Herbert C. Hoover has been persuaded to take what will probably prove to be, next to the Presidency, the most important administrative position in the country.

TERRIBLE as the War is, now that we are in it, we can see that there are also some slight advantages. Perhaps the most important is that apparently nothing else than actually being at war would have aroused the people in general to the ned of a reasonable amount of preparedness, including universal military training. If it required a war to wake us up, it is indeed fortunate one that we have one that permits us to proceed with our military preparations undisturbed even after war has been actually declared. Other countries have not been so favored. Again, if we are to accomplish much in the present struggle, we will have to learn to co-operate more all along the line, and waste less. There is good reason to believe that the lesson once learned will remain even after the return of peace, and if so, it will be good for the country both spiritually and materially.

WHAT, then, is the correct attitude toward expenditures for engineering construction? Such work is, in general, a capital expense, and, at first sight, it might seem that all available capital must be used for war-purposes, and that construction activities, except those directly connected with military operations must be suspended until after the War. However, a little thought will show that if production is to be maintained at the highest level, it will be necessary to build highways, bridges, irrigating-canals, drainage-ditches, and many other engineering works. Following this reasoning far enough, it seems as if almost any piece of construction that needs to be built in time of peace is equally important in time of war. However, it is probably true that the available capital will not be sufficient for such a construction programme. It is therefore obvious that each project must be considered by itself, always remembering that the paramount object is to win the War.

AT present, the Government seems to be inclined to co-operate with business men in every line except oil-production. In every important oilfield in the United States shipments exceed production. In California the drain on stocks continues to be from 40,000 to 50,000 bar-

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rels per day. Nevertheless, all reasonable plans for permitting development are opposed by the Secretary of the Navy, who appears to consider the hypothetical future requirements of the Navy as of greater importance than the present dire necessity of the railroads and industries of the whole country. Meanwhile, the Department of Justice continues to set technicality-traps for the unwary operator who neglected to provide himself with a complete law-library before commencing to drill for oil.

AN important victory for the oil-operators was obtained, however, in a recent decision of the Federal Court that actual drilling on the date of the first withdrawal order is not the only admissible evidence of good faith on the part of the operator according to the terms of the Pickett bill. This decision is in line with an earlier one regarding land in Wyoming. The many operators who had expended time and money in preparing to develop oil, but who, for various reasons, did not happen to be actually drilling on the date of withdrawal, will be benefited by this ruling. On the other hand, in a different case, where the operators made use of the familiar device of 'dummy' locators, the decision was in favor of the Government. An amusing feature of these oil-land cases is the extravagant estimates of value that are given in the newspapers. One particular tract of 480 acres has been reported to be worth 'millions of dollars.' As a matter of fact, it is highly improbable that the total amount of oil that can be produced from this particular land will be found sufficient to pay for the actual cost of development.

FOREST, grass, and grain fires are reported from various parts of the Pacific Coast. The danger is unusually great this year on account of the deficiency of rainfall last winter. It is probable that the loss from fires of such a character this season is already considerably greater than the total yearly expenditure for fire-prevention outside of cities. Valuable food, timber, and other products are being destroyed largely because of a particular kind of unpreparedness. This year is a good time for serious consideration of fire-fighting measures and methods outside of cities. Great advances have been made during the past few years in the use of fire-apparatus in cities, but with the exception of the United States Forest Service, and a few large corporations and others, fires in the country are being fought in about the same way as they were one hundred years ago. There was good reason for this in the days of horse-drawn apparatus, since by the time such apparatus could be brought from some distant town, the fire was either out or beyond control. The coming of reliable motor-driven engines has changed all this. An engine with a possible speed of 20 to 30 miles per hour has a large effective radius, while a patrolman carrying a small chemical-tank on a motorcycle may prevent several bad fires during the season. We believe that the counties would do well to consider the possibility of co-operation with the cities and with the Federal and State forest authorities in maintaining a sort of county fire-department with men and fire-apparatus stationed at various points so that they will be available for fighting fires outside the incorporated places.

THIS matter of fire-protection is another reason why highway construction ought not to be suspended or even checked to any considerable extent on account of the War. While it is perfectly true that we can and will get along very well without some of the boulevards and speedways that might otherwise have been constructed during the next few years, the need of more and better highways throughout the country has been emphasized by the War. From the strictly military standpoint alone, there is need of considerable road-construction. Actual invasion, however, or even the use of our roads for military purposes except in a secondary and incidental way, is not probable. But everywhere there is a need of roads to carry produce to the railroads quickly, and roads that will take part of the burden of transportation from the already overburdened railroads. As regards fire-protection, motor-driven apparatus is of no special value if the roads are impassable, or if a speed little if any greater than horse-drawn apparatus is all that can be attained. Highway expenditures should be planned with particular regard to present conditions, but in most cases, they should, if anything, be greater than in time of peace.

EXTENSION of service in unproductive territory is usually supposed to be one of the pet vices of municipally-owned utilities, but there are instances where private enterprises have made the same mistake. The Sacramento Valley Electric Railroad, which extends from Dixon Junction on the Oakland, Antioch & Eastern Railroad to Dixon, is a case in point. The road was built a few years ago, the principal stockholders being, we believe, some over-enthusiastic residents of the district traversed, and has been operated by the Oakland, Antioch & Eastern Railroad. The territory is thinly populated, and its transportation needs are already served by another railroad. The result has been that the Sacramento Valley line has made operating expenses and but little more, and there seems to be little prospect of any change. In consequence the company has asked the State Railroad Commission for permission to discontinue service. Should this be granted, as seems probable, the assets of the railroad will be sold to satisfy the claims of the creditors. These amount to $178,000, while the 'junk' value of the line is about $60,000.

CEMENT sewer-pipe is now to be given an equal chance with clay pipe in Los Angeles. This decision has been reached by the city council after a discussion which has lasted nearly eighteeen months. The new ordinance gives both materials an even chance.

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DISCUSSION

The Failure of the Echo Lake Dam

The Editor:

Sir—The *San Francisco Chronicle* for June 12 contained an editorial regarding the failure of the Echo Lake dam in which the following statements were made: "The dam went out because it was not strong enough to hold the water which it was built to impound. The fault was in the engineers who designed the dam and the contractors who built it, and back of them, the responsibility rests with the directors who approved the design and supervised the construction. * * * It is possible to build dams which will resist any strain to which they can be exposed. There are engineers who are competent to so specify that the structure will be safe. * * * and the public interest is so great that no dam ought to be constructed except upon permit by public authority on official approval of the plans."

These statements must be true of any engineering work that has failed, but in the particular instance of the Echo Lake dam, in all probability there were no engineers connected with its design and supervision, and probably no contractors connected with its construction. This dam was built by a mining company, it is believed about 1865. It was only 6 ft. high, 450 ft. long, and impounded about 600,000,000 gal. or 1840 acre-feet in a reservoir having an area of half a square mile. No plans or records of the dam survive, and probably none were made in connection with its construction, but a survey made in recent years and a surface examination showed the dam, or rather dyke or levee, to have been a combination of rock walls with earth filling. In all probability the dam, a small structure, was built directly by the labor forces of the mining company without engineering supervision or plans and without the assistance of contractors. It was recently purchased from an old mining company, and the present owners contemplated reconstruction and enlargement during the present summer. Unfortunately, after having safely impounded the waters of this lake for about 52 years, the dam failed before the contemplated improvements were begun. The property loss resulting from the failure has been exaggerated in the reports and the dam is now being rebuilt on a better basis.

It must be evident that in 1865 there were no public authorities who could pass officially on the plans. The failure of such a small structure, built during the early years of California, while in itself regrettable, should not be used as a criticism of the ability of the engineers and contractors of the present day, or as an indication of careless supervision by the public authorities over construction.

EDWIN DURYEA.

San Francisco, June 13.

Oil-Well Near El Dorado, Kansas

The Editor:

Sir—The accompanying photograph shows the 'Trapshooter No. 2 well in the El Dorado oilfield. This is the

largest well that has been obtained in the field. It is 2400 ft. deep, the oil-sand being reached at 2345 ft. The well was finished May 22 and it has been flowing at a rate of from 10,000 to 15,000 barrels per day ever since.

L. J. PEPPERBERG.

Kansas City, Missouri, June 3.

BUILDING CONSTRUCTION IN SAN FRANCISCO SINCE 1906

The following report has been issued by John P. Horgan, chief inspector of buildings, showing the building activities in San Francisco from May, 1906, to May 31, 1917:

Class	Number of Buildings	Cost
'A'	219	$ 37,912,167
'B'	245	17,923,228
'C'	3,195	90,352,630
Frame	30,257	113,694,060
Alterations	35,908	23,417,452
Public Buildings	59	7,214,892
Harbor Buildings	33	1,990,209
State Buildings	3	848,181
Panama-Pacific Exposition	83	9,951,557
U. S. Government	200	1,500,000
Total	70,202	$304,804,396

Cobalt is chiefly employed in making paints and enamels. Several years ago it was reported that Thomas A. Edison had discovered a new use for cobalt, and would require a large amount of the metal, but nothing has been heard of this recently. Elwood Hayne has made a remarkable alloy of cobalt and chromium, called stellite, that is extensively used for high-speed tools in lathe-work. It also has been employed for acid-proof edge-tools.

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The Pit River Power Project*

Construction has been commenced by the Pacific Gas & Electric Co. on a large power project at Big Bend on Pit river. The first work on this project was done by the Mount Shasta Power Corporation in 1906, when water-right filings were made, and clearing and trail-building commenced. The rights of the Mount Shasta company were acquired recently by the Pacific Gas & Electric Co., which has commenced active construction operations.

The drainage area of Pit river above the point of diversion is 4355 square miles. The greater part of the watershed is covered with lava beds. These porous beds hold back the run-off, and furnish underground storage, with the result that the flow of the stream is remarkably uniform, and the low-water flow is large, about 2450 second-feet.

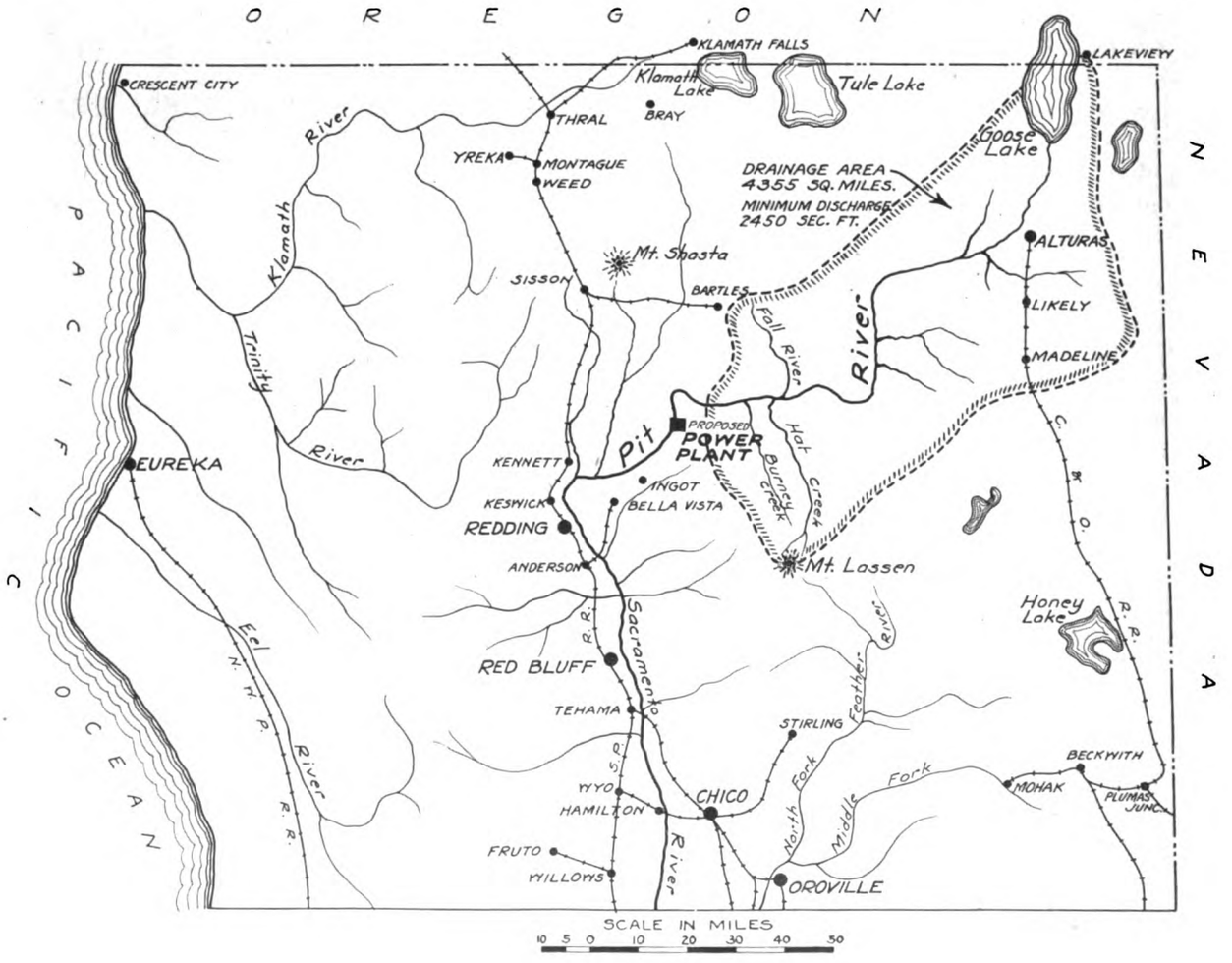
At the point of diversion, which is about 40 miles northeast of Redding, California, it is proposed to drive a tunnel seven miles long across a bend in the stream. This will give an available fall of 939 ft., sufficient to generate 180,000 hp. at low water. This can be increased considerably by storage, but the present plans do not include using more than the minimum flow of the stream. Some idea of the magnitude of the project may be gained from the fact that the total capacity of the hydro-electric plants now operating in California is 601,866 hp., according to the report of the State Water Commission.

It is estimated that the entire work will require five years and will cost $17,500,000. The first two years will be devoted mainly to driving the power-tunnel, which will be 20 ft. in diameter. No definite plans have been made for the power-plant itself, since it will not be necessary to start work on this for some time, and it is believed that there will be a considerable advance in electrical science during that time, particularly with regard to the size of generating-units.

Two 500-hp. plants to supply power for the construction-work are now being constructed, one at each end of the tunnel. Plans are also being considered for additional roads to the site.

While during flood-periods Pit river is a compara-

*From data furnished by the Pacific Gas & Electric Company.



MAP OF PROJECT

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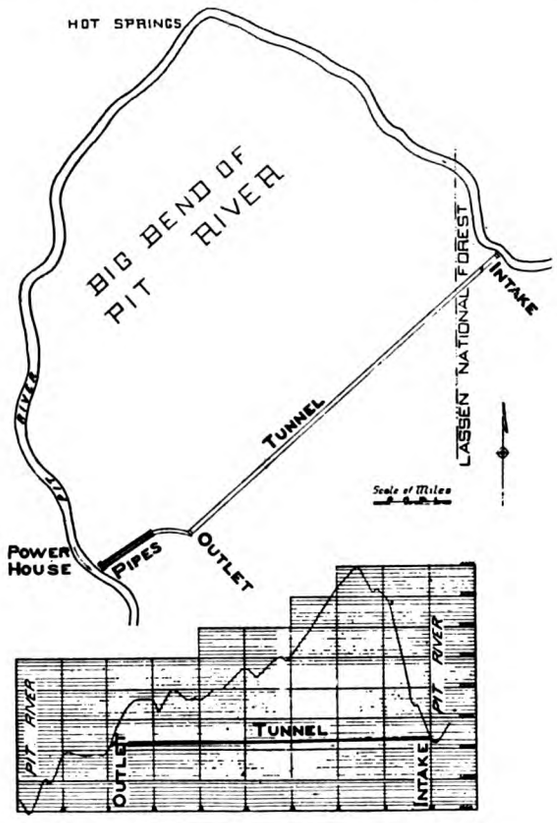


MAP AND PROFILE OF TUNNEL

tively unimportant tributary of the Sacramento, it furnishes more than half the low-water flow of that stream, which, the records show, is sometimes as small as 4000 second-feet.

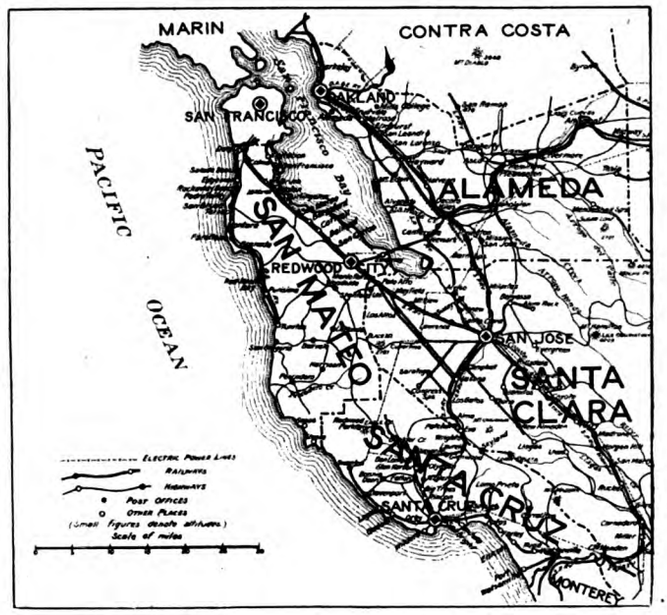
PROPOSED 'SKYLINE' HIGHWAY FROM SAN FRANCISCO TO WATSONVILLE

The proposed highway from San Francisco along the summit of the Santa Cruz range to Watsonville has recently been investigated by a committee of engineers, composed of M. M. O'Shaughnessy, city engineer of San Francisco, J. V. Neuman, I. L. Ryder, and Lloyd Bowman, county surveyors of San Mateo, Santa Clara, and Santa Cruz counties, respectively, C. B. Wing, professor of structural engineering at Stanford University and vice-chairman of the California Redwood Park Commission, and W. L. Clark, division engineer for the California State Highway Commission. This committee made a reconnaissance of the proposed routes, and a report was prepared and signed by Messrs. O'Shaughnessy, Neuman, Ryder, and Bowman. An abstract of the report follows:

The general route proposed is from the city hall at San Francisco in a southerly direction passing to the west of Lake Merced and thence down the peninsula, following the Sweeney and Cahill ridges west of the Spring Valley Water Co. reservoirs to the San Mateo-Half Moon Bay road, or else from the Sneath ranch to the east of the reservoirs to the summit, thence following the summit of the range to Saratoga summit.

From this point the road can follow the main crest of the mountains along the Castle Rock ridge to the Los Gatos-Santa Cruz State highway, and thence to Santa Cruz and Watsonville along the State and county highways; or it could leave the main ridge at Saratoga summit and follow the divide between the San Lorenzo and Pescadero creeks along the State Park road to the Ben Lomond ridge. From there the road could follow the general direction of the Empire grade to Santa Cruz and thence by the county highway to Watsonville, or else continue along the crest of the main range from the summit on the Los Gatos-Santa Cruz State highway via Burrell creek to the headwaters of Soquel creek, thence over the divide and down Corralitos creek to Watsonville.

The distance from the city hall at San Francisco to



MAP OF REGION TRAVERSED BY PROPOSED HIGHWAY

the San Mateo-Half Moon Bay road, going west of the reservoirs, is 21.3 miles. The distance by the route east of the reservoirs is about the same if the road is carried on the top of the Crystal Springs dam. If this is not feasible the length would be about two miles more, with adverse grade and heavy construction. The present road along the latter portion of this route has several stretches of 8% grade.

From the San Mateo-Half Moon Bay summit to Kings mountain is 6.9 miles; from this point to the Redwood City-La Honda road is 7 miles. From there to the Mayfield-Pescadero road is 8 miles. From there to the Saratoga summit is 15.8 miles.

The distances on the route via the State Park road and Ben Lomond ridge are as follows:

From Saratoga summit, which is 61 miles from San Francisco, along State Park road to the point of departure from it, is 10.9 miles; from this point to Eagle Rock is 6 miles; from this point to the Santa Cruz county court-house is 17.9 miles; from Santa Cruz to Watsonville along the county highway is 19 miles. The

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total distance via this route from San Francisco to Watsonville is 115.4 miles, and the estimated cost is $795,650.

Leaving the ridge route at the Los Gatos-Santa Cruz State highway summit, which is 77.4 miles from San Francisco, the distance to Santa Cruz via the state highway is 17 miles. The total distance to Watsonville by this route is 113.4 miles, and the estimated cost is is $702,900.

Following along the ridge the distances are as follows: To the head of Soquel creek, 14.3 miles; from this point to Watsonville is 15.2 miles. The total distance from San Francisco to Watsonville by this route is 106.9 miles, and the estimated cost of construction is $996,900.

Along the general route of the proposed road, with the exception of two stretches of about three miles each, there are farm roads, but most of these are not suitable in alignment and grade for the purposes contemplated in this report. Except for short portions, the present traffic on these roads is negligible.

In general, the conditions are favorable for road construction. The character of the soil varies from soft sand and loam near Lake Merced to shale, sandstone, and limestone in a few localities. The greater part of the route is through a clay-shale. Placing the road near the summit of the range minimizes drainage problems, practically eliminates bridge construction and in general gives slopes on which fills will stand. Much of the material in the cuts will stand on slopes of $\frac{1}{4}:1$ or $\frac{1}{2}:1$. The rock is disintegrated from exposure and is easily worked. The proportion of hard rock that may be excavated is small.

The estimates are based on a 25-ft. roadbed. This will allow for a pavement 18 ft. wide to be constructed at some time in the future. The minimum radius of curvature will be 100 ft. except in a few cases. The maximum grade will be 6%, with a few exceptions, particularly where existing roads are to be used. The road will rise about 2800 ft. to the summit, and, of course, go down the same amount on the other side, but there will be a comparatively small amount of adverse grade. A right-of-way at least 100 ft. wide is recommended, and it is believed that a large part of the right-of-way will be donated. On most of the road, water for sprinkling is available with a reasonable amount of pumping.

Mr. O'Shaughnessy, while in agreement with the other members of the committee as to the estimate of cost and feasibility of both routes leading from San Francisco to San Mateo, for sanitary and other reasons, believes that the road should be east of the Spring Valley Water Co. reservoirs.

The proposed road would help to relieve the present congestion resulting from the heavy automobile traffic down the peninsula. It also would be of considerable importance as a military highway. Furthermore, it would be desirable as a scenic boulevard and a stimulus to the construction of summer homes in the country traversed.

CEMENT JOINTS FOR CAST-IRON WATER-MAINS*

The pipe is placed in the usual manner. A thin backing of the best dry jute is used instead of oakum, as the jute is free from oil and grease, which should be avoided. Portland cement conforming to the specifications advocated by the American Society for Testing Materials is placed dry on a piece of canvas and moistened. When thoroughly mixed by hand it should be of such a consistence that when gripped tight it will take the form of the hand and when dropped 12 in. will crumble. The canvas containing the cement is placed under the bell, and the cement tamped into place by hand with a caulking-iron until the bell is about half-full. It is then caulked with heavy blows until the cement is packed thoroughly in the back of the socket. The process is continued until the bell is packed solid. A small bead of cement is then added, the caulking-iron being used as a trowel. As soon as the initial set of the cement in the bead has taken place, the joint is covered with earth to protect it from the air and sun.

The bead is regarded as essential because the cement packed in the bell is so dry that without protection it would absorb moisture from the water used in settling the trench. It is believed that, should the joint develop seepage when the main is placed under pressure, the cement, being dry, would expand and aid in keeping the joint tight. The joint is allowed to stand 48 hours before it is placed under pressure and the main put into regular service. Cement joints have, however, been used with satisfactory results 12 hours after completion, but this is not recommended.

At Long Beach there are now 60 miles of cast-iron water-mains, ranging from 4 to 24 in. diameter, laid with joints of this type. These mains are under pressures ranging from 40 to 80 lb. per sq. in., and are giving perfect satisfaction. On one occasion, because of the caving of one side of a trench, about 40 ft. of 6-in. main was left hanging and supporting 2½ ft. of earth. This condition lasted for over 21 hours, the main being under a pressure of 65 lb., but there was no seepage from the joints.

Paneled floor-forms were used recently in the construction of a large concrete building at St. Paul, Minnesota, according to an article by J. C. Worrell in *Cement and Engineering News*. The forms for the floors and also for the walls of the basement were made in panels 4 by 6 ft. When placed as forms for the floors these panels rested on 4 by 6-in. posts, spaced 4 ft. apart. The panels were made of 1-in. lumber nailed to 2 by 4-in. pieces spaced 12 in. apart. By using these panels the speed of laying the floor was increased, and breakage of lumber when removing the forms was reduced to a minimum. After being used several times in the construction of the building, the panels were still in good condition.

*Abstract of paper presented before the American Society of Civil Engineers by Clark H. Shaw.

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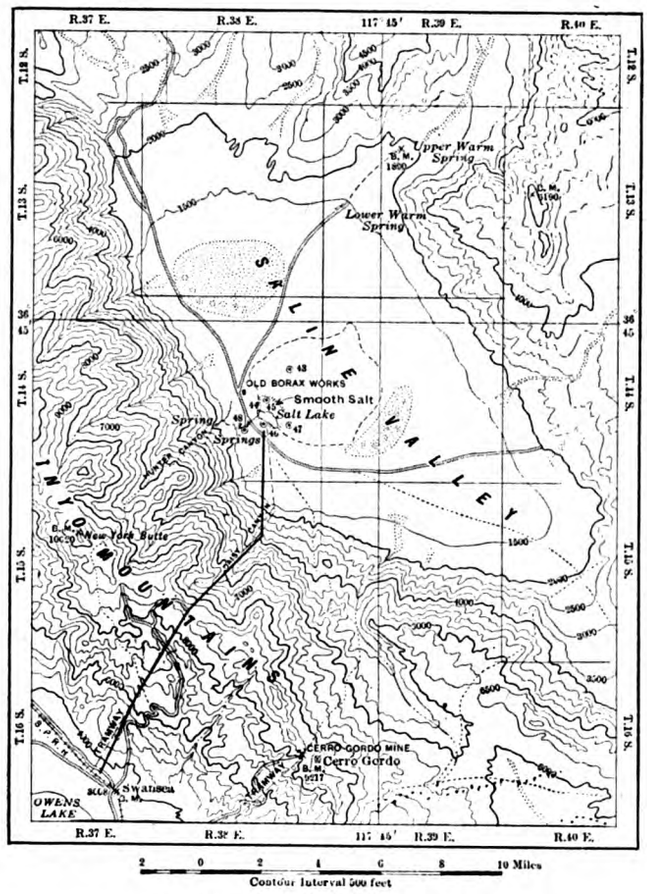
Saline Valley Tramway

By F. C. CARSTARPHEN

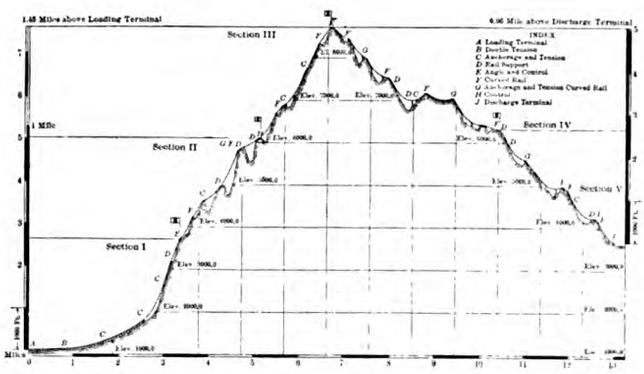
*Saline valley is situated in Inyo county, California, about 20 miles north-east of Owens lake. It is separated by the Inyo mountains from the Southern Pacific railroad running through Owens valley. The valley has no outlet, but there are several large springs and a constant flow of water in Hunter canyon. There is a large deposit of salt covering about 1500 acres of the floor of the valley. The existence of this salt deposit has been known for some time, but lack of transportation facilities prevented its commercial development. Topographic conditions render the economical construction of a railroad into the valley impracticable. A pipe-line across the Inyo mountains by which brine could be pumped to evaporating-vats near the railroad in Owens valley was also considered, but this plan was abandoned. While it was found feasible as a means for transporting the brine, it did not provide for bringing in supplies needed by the operations incidental to collecting the salt and pumping. Accordingly an aerial tramway was given the preference. After the surveys were completed, a contract was let by the Saline Valley Salt Co. to the Trenton Iron Co., a subsidiary of the American Steel & Wire Co., for the construction of a Trenton-Bleichert tramway. It was designed to carry salt weighing 60 lb. per cu. ft., the slope-length being 69,645 ft., the capacity, 20 tons per hour, the elevation of the discharge-terminal above the loading-terminal, 2450 ft., the carriers to have a volume of 12 cu. ft., and the speed of the traction-rope to be 500 ft. per minute. This required a spacing of 525 ft., or an interval of 63 seconds between carriers. About 112 hp. is required for the operation of the tramway. The principal equipment exclusive of structures and operating machinery is as follows:

1¼-in. steel track-cable, feet	13,850
1½-in. steel track-cable, feet	55,450
⅞-in. steel track-cable, feet	69,300
¾-in. steel traction-rope, feet	141,000
Steel buckets	286
Track-cable saddles	240
Steel traction-rope rollers	240

From the loading-station at the edge of the salt-field, which has an elevation of 1060 ft., the tramway runs south along the mesa for 2¾ miles to the eastern foot of the mountains, at an elevation of 1800 ft. From that point the ascent is rapid to the control station No. 1, where an elevation of 3720 ft. is attained. This part of the line is known as Section I. At station No. 1 there is a horizontal angle of 35°30′. Section II extends to control station No. 2, which has an elevation of 6100 ft. Section III extends to control-station No. 3 at the summit, where there is a horizontal angle of 2°28′. Section IV extends to control-station No. 4, which has an elevation of 6330 ft. At this point there is a horizontal angle of 10°48′. Section V extends to the discharge-terminal on the narrow-gauge line of the Southern Pacific railroad. The elevation is 3625 feet.



MAP OF SALINE VALLEY AND THE TRAMWAY



PROFILE OF LINE

*Abstract: Proc. Am. Soc. Civil Eng., by F. C. Carstarphen, tramway engineer, American Steel & Wire Co., Trenton, New Jersey.

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For transportating material on the western slope of the mountains, it was possible, by making use of an old road and extending it, to construct a wagon-road to the summit, the total distance from the valley being 10 miles. At one point on this road there was a stretch of 300 ft. with a grade of 25%, and this grade could not be eliminated or reduced except at prohibitive cost. This became the ruling grade for hauling material between control stations 4 and 1, and limited the maximum load for eight-horse teams to 5000 lb., heavier loads requiring 10 or 12 horses. A camp was established 3½ miles west of the summit. Teams made one round trip per day between the railroad and the camp. Those quartered at the camp hauled the wagons from that point to the summit, where the material was unloaded, three round trips being made in two days. For every 100 tons of construction material hauled from the railroad to the camp, 1.5 tons of grain, 7.7 tons of hay, and 33 tons of water had to be transported. The cost of maintaining a team consisting of eight horses and a driver was $15 per day at the railroad. On account of hauling feed and water from the railroad, the cost of a team at the camp was $21 per day. Construction of roads on the eastern slope of the Inyo mountains was found impracticable, although a trail was constructed from the summit to Saline valley. Since a large part of the machinery was too heavy to be moved by pack-animals, temporary double-cable reversible tramways were constructed for transporting material for the structures on Sections I and II. The diameter of the track-cables used was ¾ in. and of the traction-rope, ⅜ in. The cost of transporting this equipment from the end of the wagon-road at the summit was as follows: 600 tons of material was moved 8300 ft. at a cost of $4.20 per ton; 375 tons 2600 ft. farther at a cost of $2; 260 tons 4000 ft. farther at $3.50; and 210 tons 2700 ft. farther at a cost of $2.90 per ton.

The cost per day for the crew to operate, load, and unload these temporary cableways was from $35 to $42. The capacity in tons per day, while operating, ranged from 13.3 to 33.3 tons. Allowing for the time required for constructing, taking down, and moving, the capacity ranged from 6.3 to 19.3 tons. The material for control-station No. 1 was carried on a temporary cableway from the floor of Saline valley. A wagon-road runs from Big Pine on the railroad, 55 miles to the floor of Saline valley. About 375 tons of material was hauled over this road at a cost of $35 per ton. Some of the other material was moved from the summit down Daisy canyon on a sort of sled. The cables between the summit and control-station No. 2 were strung by letting them down the mountain-side by gravity. From three to five men were required at the lead-end to put the cables on the traction-rope guide-sheaves at the towers and stations. Wooden blocks 4 by 8 in., bolted together, were used as brakes to control the velocity of the cables. From the floor of Saline valley to control-station No. 1 the cables were handled with a winch driven by a gasoline-engine. On Sections IV and V the cables were strung and placed under tension in the usual manner, except that on Section V the grade was sufficient to make it desirable to use the gravity method. In placing the traction-rope for Sections II and III, it was threaded around the grip-sheave at the summit station. The grip-sheave acted as a driving-sheave, because of the use of a brake on the reel, which imposed tension in the traction-rope before it passed around the grip-sheave. The traction-rope was also passed through hauling-clamps before reaching the grip-sheave, in order to hold it when splices were being made, or in cases of emergency. After bringing the traction-rope for one side to control-station No. 1, the upper end at the summit was snubbed and the rope for the opposite side was let down in the same manner. After the upper ends had been spliced, the ropes were cut at control-station No. 2 and passed around the tension and grip-sheaves of this station.

The towers and structures are carried on concrete foundations, the water required for making the concrete being hauled in tanks or packed by mules for distances ranging from 1 to 7 miles. This was also necessary for the water required for the camps, except those at the railroad, in Daisy canyon, and at Saline valley.

The tramway was completed and the first bucket of salt hauled on July 2, 1913, power being obtained from the Los Angeles aqueduct. The line worked satisfactorily when the buckets were loaded about two-thirds full. When efforts were made to carry full buckets, it was found that the number of accidents resulting from carriers slipping on the traction-rope was excessive. An investigation showed that while the tramway had been designed to carry air-dried salt, which weighs 60 lb. per cu. ft., the average weight of the wet salt was 80 lb. per cu. ft. It was also noted that while buckets loaded with dry salt were carried without difficulty, when wet salt was being transported, a few of the buckets would slip on the traction-rope, particularly on the steeper parts of the tramway. With the exception of the first 2½ miles on the floor of Saline valley, the cables throughout almost the entire line had a slope exceeding 30%, and in some cases this slope exceeded 85%.

The principal departure from standard tramway-practice was the division of the distance between the loading-terminal and the summit into three sections, and the distance between the summit and the discharge terminal into two sections. Experience has shown that it is not economical to attempt to use traction-ropes of large diameter. The total stress developed in such ropes when lifting 20 tons of material through a vertical distance of 1½ miles at a rate of 500 ft. per minute is too great to permit the use of a single rope. Multiple traction-ropes, arranged in parallel, are not satisfactory. Accordingly, the tramway was constructed in sections so as to permit the use of a traction-rope of moderate diameter. The stations were arranged so that there would be a constant difference in their successive elevations, giving essentially the same stress on the traction-rope of each section. These stresses, however, are not absolutely constant, because the friction developed by the moving carriages varies with the length of the different sections. Ex-

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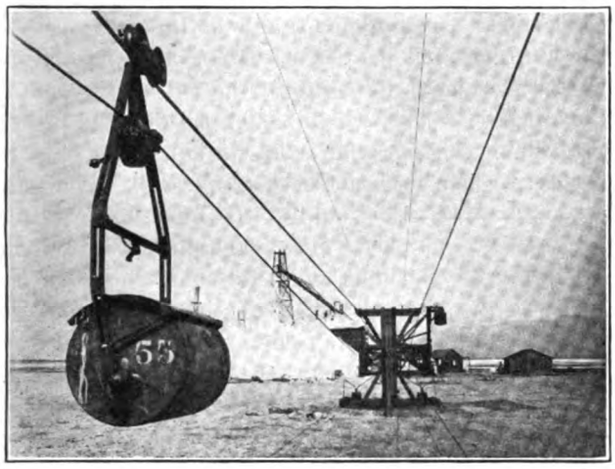
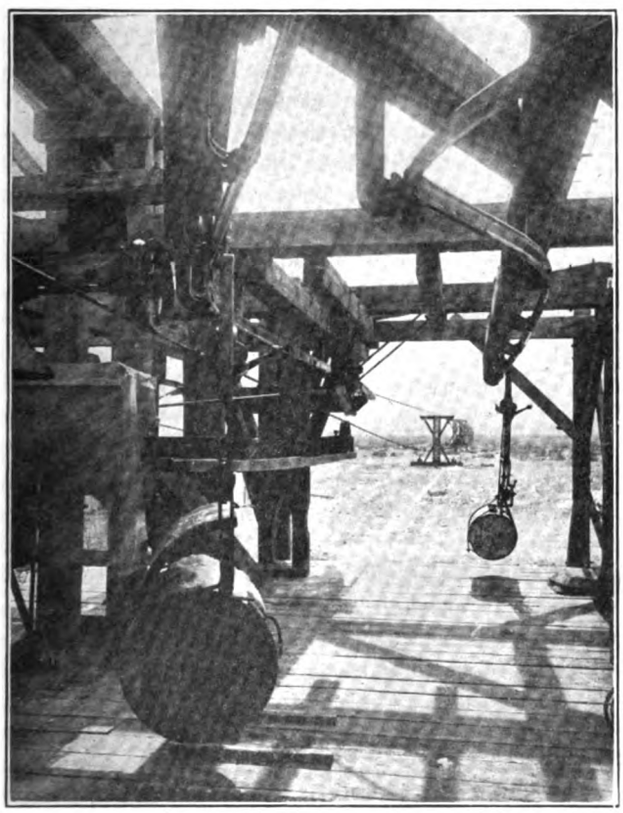
perience has shown that, irrespective of the constancy of tension in two traction-ropes in service, they do not maintain precisely the same diameter. Consequently, friction-grips that will hold satisfactorily on the larger of



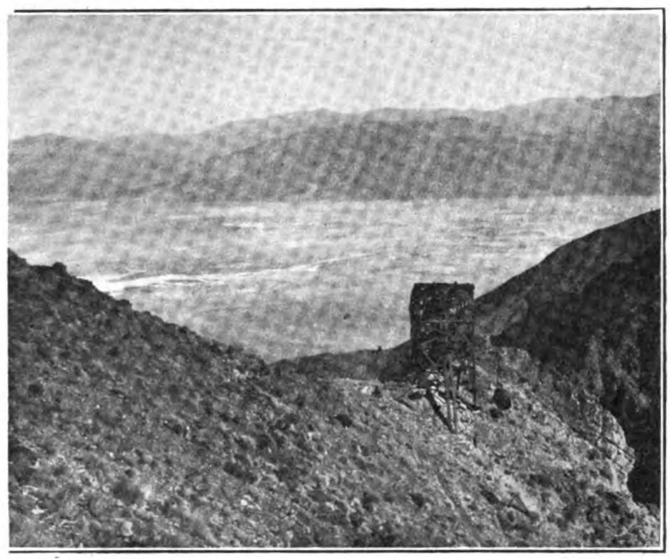
BUCKET LEAVING LOADING-TERMINAL

the ropes are likely to slip on the smaller one. For this reason the Webber grip was not used. The Pohlig screen-grip was also rejected because of the acceleration required to close the gripping-lever, which moves in a plane



BUCKET OF SALT AT LOADING-TERMINAL

parallel with the direction of motion; also because of the difficulty of maintaining a proper limit for the throw of the closing-lever when operating on ropes of different diameters, so as to engage the detacher properly instead of under-running it. The overhead Bleichert-grip was rejected because the tension of the traction-rope in passing through the structures on the crests tended to overturn the carriers, especially those on the empty side. The under-hung Bleichert-grip was rejected because it is operated by the weight of the load acting on the movable jaw, and it was feared that on the steeper grades this would not be sufficient to keep the carriers 'from slipping on the rope. This type of grip and carriers is also expensive as compared with others. This is an important consideration in view of that fact that 286 carriers were required. A special grip of the under-hung, top-opening, trunnion type was therefore designed. These grips were used on the line for some time, but were not satisfactory, slipping occasionally on the extreme slopes, because of the variation in the weight of the salt.



SALINE VALLEY FROM POINT NEAR SUMMIT

Finally the American Steel & Wire Co. took over the operation of the line in order to determine what defects existed and what replacements should be made. As a result of this investigation, a new grip, the Universal Wico, was designed, and it has been used from that time with satisfactory results. This grip requires a force of about 40 lb. on the closing-lever to fasten it. It will hold a carrier loaded with wet salt on the steepest grades. A special lubricating-system is attached to the carriers to provide an adequate supply of oil for the wheels and pins.

Sections III and IV are controlled from the summit, both driving-sheaves being mounted on the same shaft. The power developed by the descending loads on Section IV assists in raising those on Section III. As the carriers on Sections I, II, and III are being lifted, there is a possibility of the line reversing its direction of motion, on account of the unbalanced weight of the carriers on the two sides. Accordingly, each of the stations is equipped with a reverse-preventer. This consists of a large circular plate fitted with shoes containing ball-races, which are under the control of a centrifugal governor. When the governor is up to speed, the balls are restrained so that the plates run freely. When the line

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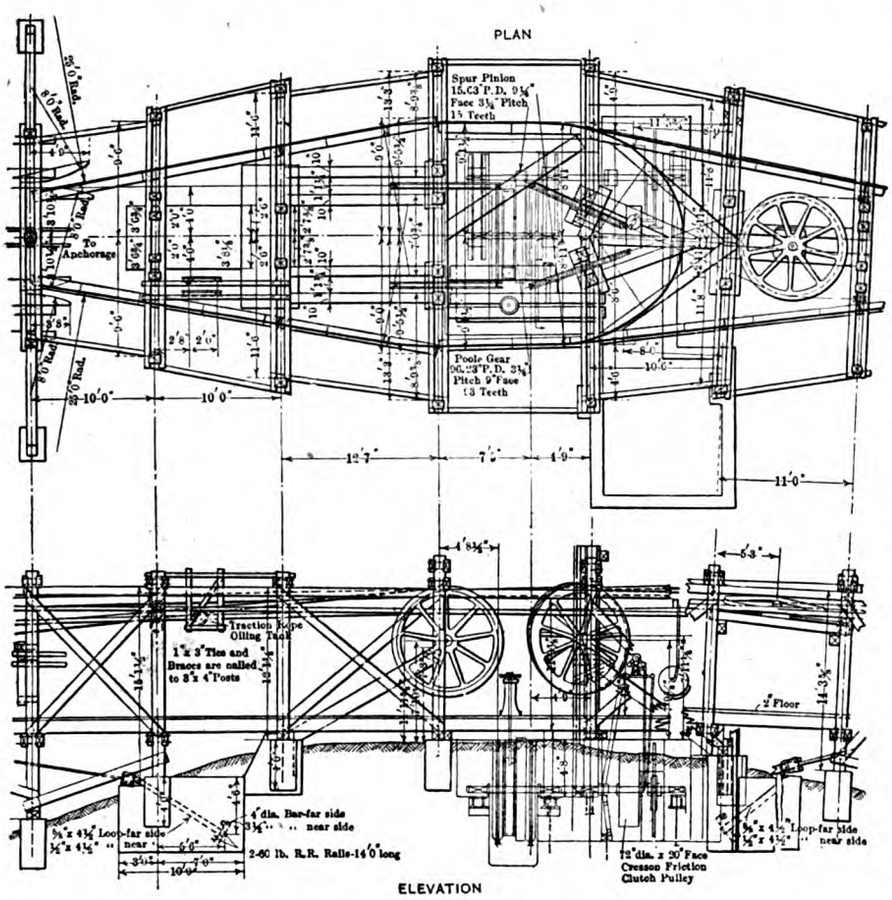
stops the balls immediately nip the plate, and a reversal of motion is prevented. The drives at the stations are similar in design, except that, as already mentioned, the two sheaves at the summit are mounted on the same shaft. The drives consist of an 8-ft. grip-sheave bolted to a brake-run 7 ft. 2 in. diam., with a 12-in. face, and this, in turn, carries an 8-ft. spur-gear. The latter is driven by an 18-in. pinion mounted on a shaft fitted with a friction-clutch belted to a 75-hp. Allis-Chalmers, 3-phase, 2200-volt, induction motor. On Section V, this motor acts as a dynamo-brake instead of serving as a driver.



CONTROL-STATION AT SUMMIT

The grip-sheaves carry a special rim, in which there are 96 pairs of toggle-jaws. The jaws are held open by gravity or by a special flat spring. When the traction-rope passes around the sheave, the pressure developed on the bottom of the groove on the jaws is sufficient to cause them to close and grip the rope tightly. This increases the friction between the sheave and the traction-rope, augmenting the efficiency. The brakes are of the compound-differential type, and are actuated by hand-wheels and screws. This ensures their being applied gradually, so that the line may not be wrecked by sudden stoppage, as might be the case with brakes operated by a solenoid.

The hangers on the carriers are made longer than in standard practice, so as to provide clearance between the traction-rope guide-rollers used in the rail-structures on the ridges that run transversely to the line of the tramway. The buckets are covered to prevent dust from reaching the salt. The covers are provided with a special latch to prevent their being blown open by the high winds that frequently occur. The control-stations are equipped with telephones and the line-riders also carry telephones, which may be attached to the line at any point, in addition to which there is a bell-signal system. The electrical transmission-line is of the usual pole-construction, carrying copper wires for a 3-phase circuit. The transformer-stations are of the out-door type. The line-voltage is 33,000, which is stepped down to 2200 for use in the motors of the driving stations. The crew consists of two men each at the loading and discharge-stations and at the four control-stations on the line. There are also four line-riders and a foreman who has general supervision of the entire line. The tramway carries 23 to 24 tons of salt per hour at a cost for labor and power of 4.6c. per ton-mile. The line is not designed for passenger-service, but the line-riders use it in preference to following the rough trails on horseback.

Several methods of gathering the salt have been tried with varying success. At present the plan is to flood the salt-field with water piped from the springs. The fresh water dissolves the salt rapidly. If the supply of fresh water is then stopped, evaporation caused by the summer sun is excessive, and pure salt-crystals gather in the brine, resembling flat plates that are easily shoveled into conical piles about 2 ft. high and 3½ ft. in diameter at the base. Each pile is assumed to contain from 400 to 500 lb. The piles are arranged in rows approximately 12 ft. apart, the spacing between the piles being 6 ft. Mexican labor is found to be most satisfactory in gathering salt. Each man piles from 8 to 10 tons per day. Theoretically, the salt remains in piles until the brine has drained. As the mother liquor contains most of the impurities which might contaminate the salt, this step is an additional insurance of its purity. However, the salt does not drain freely, but remains damp for a considerable time. When the salt is gathered, a buggy of a special type is used, made of galvanized iron and having a body with a channel-like cross-section. Since the ground is soft, the rear wheels are 20 in. diam. and have a 12-in. face. The front wheels are 16 in. diam. and have a 4½-in. face. The bed is 3 ft. wide, 8 ft. long, and 6 in. deep. The axles are attached rigidly to the body, so that curves are turned by slipping the front wheels. These buggies carry from 500 to 1000 lb. of salt, and are hauled across the field by a ⅜-in. cable operated by a gasoline-engine. At the dumping-point the buggies are pulled up an incline plane until they assume an angle of approximately 44°, at which slope the wet salt slides freely into

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a hopper above a car which has a body 30 in. wide, 4 ft. 6 in. long, and approximately 30 in. high. The bottom of this car is hoppered both ways at an angle of 45°, so that the sides, instead of the ends, are used for doors. These cars are operated on a double-track railway, about ½ mile long, by an endless-rope haulage-system operated at a speed of 200 ft. per min. A 10-hp. gasoline-engine moves seven loaded and seven empty cars on these tracks. The cars dump into a boot serving a drag-conveyor, which elevates the salt to a point high enough to command the 50-ton bins at the loading-terminal. Here the tramway-buckets are filled by a lever-chute of the ordinary type. The bucktes are dispatched from the loading-terminal at the tap of an automatic gong. The rate established is 56 buckets per hour.

White Smith was president, W. H. Leffingwell, chief engineer, Daniel Kuhnle, superintendent, M. O. Bolser, electrical engineer, and Harry Hilderman, foreman of construction for the Saline Valley Salt Co. Among the engineers of the Trenton Iron Co. and the American Steel & Wire Co. who took part in the construction of the tramway were S. S. Webber, F. C. Carstarphen, William Hewitt, C. H. Wickham, L. T. Hays, T. J. Murphy, R. H. Hall, and George Hall.

BUREAU OF STANDARDS—SCREEN-SCALE

Uniformity in technical statement facilitates interchange of data and their correct interpretation. Screen-analyses often lack the value that should attach to them, by reason of the diverse standards used. Unless the exact size of screen-opening is known the relation between undersize and oversize is not significant to the metallurgist. The successive sizes of screen-openings must be based upon some exact mathematical relationship in order that the successive over-size quantities may be of service to the operator in solving problems of treatment. Neither does the cumulative curve deduced from the grouping of the successive over-size products furnish a valuable guide unless the ratio of successive screen-openings is dependent on a law which gives a true mathematical curve. None of the proposed standard sets of screens has withstood criticism. As a matter of convenience, and to avoid confusion, mill experimenters have quite generally taken advantage of the Tyler set of screens made especially for this purpose. These are based upon the specifications of von Rittinger, in which the diameters of the successive sizes have a constant ratio of 1.414, that is, the square root of 2, while the areas of the successive openings have a constant ratio of 2. The Bureau of Standards of the Department of Commerce now proposes a standard screen-scale for testing-screens, recommended for common use after having been adopted by a conference of representatives from the American Society for Testing Materials, the American Society of Civil Engineers, the American Institute of Mining Engineers, and other societies. The scale is based on an opening of one millimetre. Sieves in the series with larger openings than 1 mm. are related to the unit-size by a constant difference in diameter of openings equal to the square root of 2 or 1.4142, while the finer sizes in the series of screens, having openings less than 1 mm. in diameter, differ by a constant equal to the fourth root of 2 or 1892. Details of the series from an 8-mm. diameter of opening to 0.044-mm., making 25 screens in the set, are shown in the accompanying table.

BUREAU OF STANDARD'S SCREEN-SCALE

Opening, mm	Mesh	Wire diam., mm.	Ratio diam. to opening	Tolerances Mesh	Tolerances diam., mm.
8.00	1	2.00	0.25	±0.01	±0.08
5.66	1.4	1.48	0.26	±0.01	±0.08
4.00	2	1.00	0.25	±0.02	±0.05
2.83	2¾	0.81	0.29	±0.02	±0.05
2.00	3.9	0.56	0.28	±0.04	±0.05
1.41	5	0.59	0.42	±0.08	±0.025
1.00	7	0.43	0.43	±0.15	±0.020
0.85	8	0.40	0.47	±0.2	±0.015
0.71	9	0.40	0.56	±0.3	±0.012
0.59	10	0.41	0.69	±0.4	±0.012
0.50	12	0.33	0.66	±0.4	±0.012
0.42	14	0.29	0.69	±0.6	±0.010
0.36	16	0.26	0.72	±0.6	±0.010
0.29	20	0.21	0.72	±0.8	±0.010
0.25	23	0.185	0.74	±1	±0.008
0.21	27	0.16	0.76	±1	±0.008
0.17	31	0.15	0.88	±1	±0.008
0.14	39	0.116	0.83	±1	±0.008
0.125	47	0.089	0.71	±1.5	±0.008
0.105	59	0.064	0.61	±2	±0.008
0.088	67	0.061	0.69	±2.5	±0.005
0.074	79	0.053	0.72	±3	±0.005
0.062	98	0.040	0.65	±3.5	±0.005
0.052	110	0.039	0.72	±4	±0.004
0.044	127	0.035	0.80	±5	±0.004

WOODEN SHIPS FOR THE FEDERAL GOVERNMENT

Plans for wooden ships to be built for the Federal government have been completed and contracts for about fifty of these vessels have already been awarded to various shipyards on the Pacific Coast.

The plans provide for a vessel 281 ft. 6 in. over all, 268 ft. long between perpendiculars, 36 ft. beam over planking, 45 ft. 2 in. beam molded, 26 ft.depth molded, and 23 ft. 6 in. load draught, with about 3000 tons deadweight. About 1,500,000 ft. B.M. of lumber will be required.

The hull construction is of the single-deck type, with open holds and ' 'tween-deck' beams. The frames are double 12 by 12 in., moulded 13 in. at the keel and tapering to 10 in. at the deck, spaced 36 in. Alternate designs for the frames have been provided, one for use when yellow pine is to be employed, and the other for Douglas fir.

The ships will have a speed of 11 knots, and will carry 30 seamen and 12 gunners. They will be electric lighted and equipped with wireless. Propulsion will be by steam or internal-combustion engines of 150 hp., driving twin screws. Additional contracts will be awarded soon.

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Notes on Compression and Transmission of Air

By ROBERT S. LEWIS

Air-compressors are rated by manufacturers on the basis of piston displacement, or volume swept through by the piston, expressed in cubic feet of free air (air under atmospheric conditions of pressure and temperature) per minute. If compressors delivered this quantity of free air as compressed air such a rating would be satisfactory, but various factors modify the intake-capacity of a compressor so that it may be much less than the piston displacement. The ratio of the free air taken into the cylinder to the piston displacement is called volumetric efficiency, and may be expressed in the form of the equation:

$$(1) \qquad E_v = \frac{\text{cu. ft. of free air taken into compressor}}{\text{displacement of compressor in cu. ft.}}$$

The important factors which modify volumetric efficiency are clearance, volume of the piston rod, heating of the air before compressing, leakage of air past the piston and also intake and discharge valves, too small area of valves and the wrong operation of mechanically controlled valves.

The space between the piston, when at the end of its stroke, and the head of the cylinder is filled with compressed air which cannot be discharged. During the return stroke this air must expand until it is at atmospheric pressure before any free air can be drawn into the cylinder. If this clearance space is large, the free-air intake-capacity of the cylinder is materially reduced. In well designed single-stage compressors clearance, expressed as a percentage of the displacement per stroke, is not far from 1% for the large sizes and may be 2% or more for the small sizes of compressors. This means that for a low clearance-value the distance between the piston at the end of its stroke and the cylinder head is only 1/16 or even 1/20 of an inch. The effect of clearance increases as the ratio of compression (final absolute pressure to initial absolute pressure) becomes greater. For large ratios the piston must travel a considerable part of its stroke before any free air can be drawn into the cylinder. If it were possible to compress to 5000 lb. per sq. in. in a single cylinder no air would be taken in during the return stroke. The air in the clearance space, when expanded to atmospheric pressure, would completely fill the cylinder. Assuming that this clearance-air expands isothermally, which is probably more nearly correct than if it is considered to expand adiabatically, the effect of clearance may be calculated as follows:

Let E_c = volumetric efficiency depending upon clearance.

C = clearance expressed as a decimal.

r = ratio of compression = $\frac{P}{P_a}$, P being final absolute pressure in pounds per square inch, and P_a being the initial absolute pressure. (Absolute pressure is gauge-pressure plus atmospheric pressure.)

$$(2) \qquad \text{Then } E_c = 1 + C(1 - r)$$

Thus, when compressing from an atmospheric pressure of 14.7 lb. to 100 lb. as shown on the gauge, with clearance = 2%, then $r = \frac{100 + 14.7}{14.7} = 7.8$, and $E_c = 1 + 0.02\ (-6.8) = 0.864 = 86.4\%$. In case the clearance of a compressor is not known, it can often be determined by measuring the volume of water required to fill the clearance-space. The effect of clearance upon volumetric efficiency is lessened by using stage-compression. Since the air is not compressed to the final pressure in a single cylinder, the percentage of the volume of the low-pressure cylinder occupied by the expanded clearance-air is reduced. The piston rod occupies space on one side only of the piston, consequently the displacement per revolution, corrected for clearance, less the volume of the piston rod, will give the free-air intake-capacity of the compressor per revolution.

Under constant pressure, the volume of a given weight of air is proportional to its absolute temperature (460 + F°). At 60°F., a given volume of air will expand 1/520th of its volume at this temperature for each degree Fahrenheit rise in temperature. If one cubic foot of air at 60°F. is heated to 100°F. as it enters the compressor its volume will be increased 40/520ths, or approximately 8%. In other words a cubic foot of air at 100°F. is equivalent to 92% of a cubic foot of air at 60°F. The power required for compressing a cubic foot of air, once it is in the cylinder, is independent of the temperature of the air. This means that the colder the air is when taken into the cylinder the less will be the number of cubic feet required to give a desired result. For this reason care should be taken to get the air into the cylinder at as low a temperature as possible. The intake-conduit for the compressor should be made of a non-conducting material, such as wood, brick, or concrete, and should draw air from the coolest place available, never from the compressor-room itself. The cross-sectional area of the conduit should be equal to at least one-half the area of the piston in order that the air can flow freely without obstruction. In hot and dusty localities it has been found beneficial to draw air from the interior of a framework covered with burlap or sacking, which is continuously drenched by a spray of water. This procedure not only cools the air, but removes the dust at the same time.

If a compressor has poorly designed intake-passages, the air as it enters the cylinder may be at a temperature several degrees above that of the atmosphere. The metal

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of the cylinder becomes quite hot after a compressor has been running for an hour or more, and, after traveling through long and narrow intake-passages, the air may be heated to 100°F. or above.

Let T_c = absolute temperature of the air after entering the cylinder, and T_a = atmospheric absolute temperature, then

$$E_v = E_c \frac{T_a}{T_c} \tag{3}$$

This is the expression for volumetric efficiency modified by clearance and heating of the intake-air.

Leakage past valves and piston will further reduce the intake-capacity of a compressor. If the area of the intake-valves is too small the cylinder will not be filled with air under atmospheric pressure, and, if the area of the discharge valves is too small, all the air will not be discharged. Poppet valves depend upon a difference in pressure on the two sides of from 3 to 5 oz. for their action, and may reduce volumetric efficiency by as much as 2 to 4%. Mechanically operated valves of the Corliss type are very satisfactory, but they must be maintained in correct adjustment. Though the effect of clearance, and of heating the air before compressing, can be calculated by the formulas it is well to bear in mind that the results so found may not always agree with the actual conditions of operation. The leakage of air past valves and piston, the choking of air-passages, and bad valve-action, are variables that cannot be determined by formulas. Volumetric efficiency is most accurately computed by measuring the air delivered and comparing it with the displacement of the compressor. Such a method includes all factors affecting the performance of the machine.

When the ratio of compression is large the final temperature of the air in the cylinder may be very high. The relation of temperature to volume and pressure is given in the following equation:

$$T_2 = T_1 \left(\frac{V_1}{V_2}\right)^{n-1} \tag{4}$$

$$T_2 = T_1 \left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} \tag{5}$$

The subscripts 1 and 2 indicate initial and final conditions respectively. P and T are in terms of absolute pressure and temperature. Volumes V are in cubic feet. The value of n for perfect adiabatic compression is 1.406. For an initial temperature of 60°F., a final gauge pressure of 100 lb., and atmospheric pressure of 14.7 lb., the final temperature of the air would be

$$T = (460 + 60)\left[\frac{14.7 + 100}{14.7}\right]^{0.29} = 520(7.8)^{0.29} = 931^\circ \text{ abs.} = 471^\circ\text{F.}$$

Should some of the hot compressed air leak back into the cylinder, or should the ratio of compression be increased by throttling of the intake-air through sticking of the valves, the temperature may be even higher than the above theoretical value. That such high temperatures are reached in practice is shown by the explosions that occasionally take place in compressors and receivers. An air cylinder, unlike a steam cylinder, requires only a small quantity of oil, a drop once in four or five minutes should ordinarily be sufficient. The use of too much oil causes an accumulation of carbon that may choke the valves and passages. Kerosene, often employed for cleaning valves, has a flash point of 150°F. or less, and ordinary lubricating oils have flash points varying from 330° to 425°F. In view of the high temperatures that may be reached in the cylinder, such oils are obviously a source of danger. Only a thin air cylinder oil, with a flash point of 600° to 630°F., should be used. For cleaning valves, a mixture of soft soap and water should be fed through the lubricating cups once or twice a week. As a safety measure, it is advisable to place a thermometer or fusible plug in the discharge pipe, and as near the compressor as possible.

For pressures up to 75 lb. per sq. in. single-stage compression is satisfactory, but for pressures from 75 to 150 lb., which are commonly used in mining work, two-stage compression is preferable. The ratio of compression in a cylinder of a two-stage compressor is equal to the square root of the ratio of compression in a single-stage compressor delivering air at the same final pressure; consequently losses in capacity due to clearance and leakage are materially lessened. The inter-cooler of a two-stage compressor will reduce the temperature of the heated air from the low-pressure cylinder nearly to that of the atmosphere before it enters the high-pressure cylinder; therefore the final temperature of the air is lower than for single-stage compression, and lubrication is facilitated. However, the sticking of valves, or the choking of passages, may cause such a high temperature to be reached in the high-pressure cylinder that an explosion will occur, even in a compound compressor.

The theoretical work of compression may be easily calculated with the aid of chart No. 1, constructed by the Nordberg Manufacturing Company.

Curve *a* is for isothermal or ideal compression.

Curve *b* is for three-stage compression.

Curve *c* is for two-stage compression.

Curve *d* is for single-stage or adiabatic compression.

First compute the ratio of compression. Find this figure on the bottom scale and project vertically to intersect the curve for the given method of compression. From this point pass to the left margin and find the horse-power required per pound of atmospheric pressure. Multiply this figure by the atmospheric pressure, and the result will be the theoretical horse-power required to compress 100 cu. ft. of free air. What is the horse-power required for compressing 500 cu. ft. free air from 11 lb. atmospheric pressure to 110 lb. gauge-pressure, two-stage compression? Here $r = \frac{(110 + 11)}{11} = 11$, and for curve *c* the air horse-power is 1.25. Multiplied by the atmospheric pressure of 11 lb. this gives 13.75 hp. for 100 cu. ft. free air, or 68.75 hp. for 500 cu. ft. The advantage of this chart lies in the fact that it is applicable to compression at any altitude. The actual horse-power required will be slightly less than that given by the chart for adiabatic or single-stage compression,

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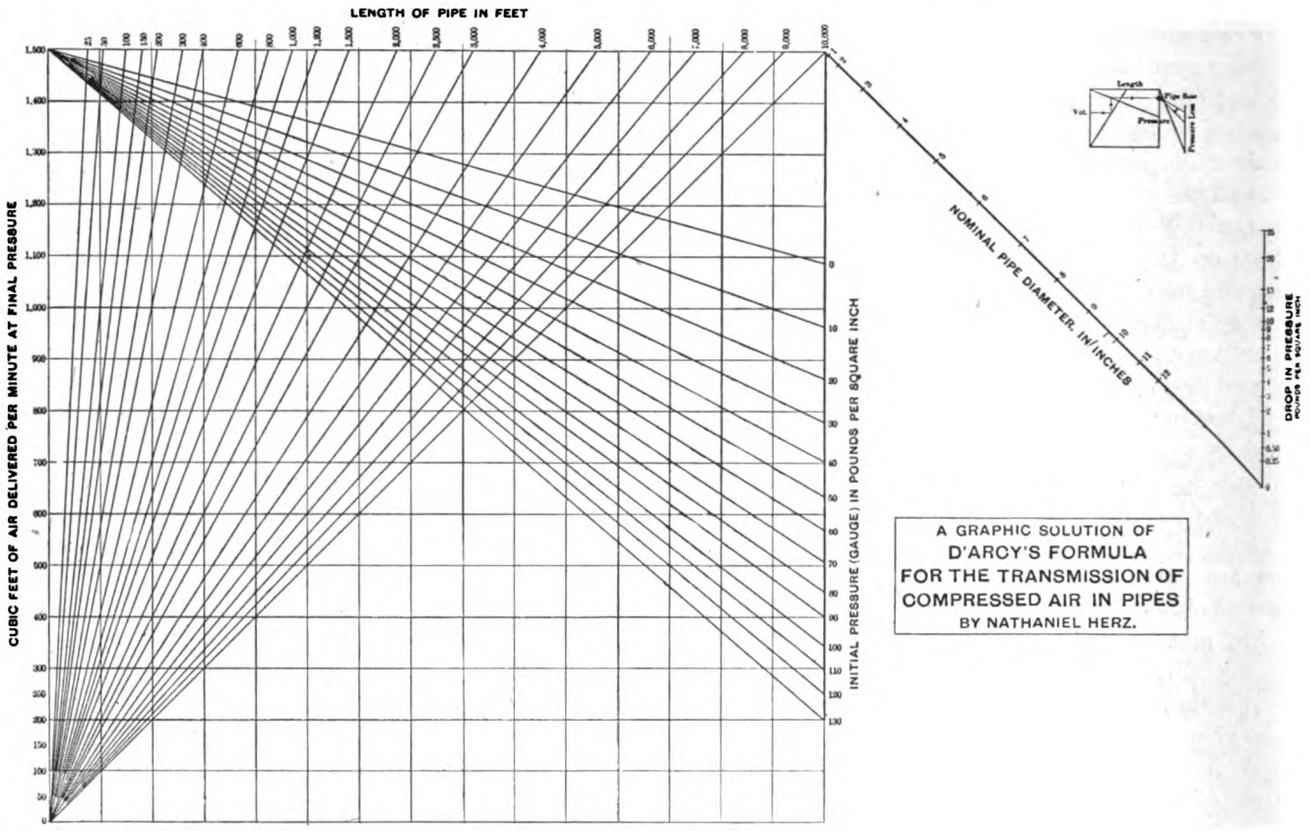
and a little greater than that given for two and three-stage work. Full adiabatic compression, or compression with no loss or gain of heat from any outside source, cannot be attained in practice because compressors are water-jacketed and have some cooling effect on the air. The inter-cooler used in stage-compression should cool the air to the temperature of the atmosphere, but this efficiency is not reached. Atmospheric pressure varies with the altitude at which it is measured. Its value at sea-level equivalent to a cubic foot of air at the given altitude is $\frac{P_a}{P_s}$. For an elevation of 8000 ft. this ratio is $\frac{11}{14.7} = 75\%$. This means that every cubic foot of air at 11 lb. pressure is equivalent to only 0.75 cu. ft. of air at sea-level. Since a compressor, operating at a high altitude, will deliver less air than if operating at sea-level, its power-consumption must be less, but power-consump-


LENGTH OF PIPE IN FEET
CUBIC FEET OF AIR DELIVERED PER MINUTE AT FINAL PRESSURE
INITIAL PRESSURE (GAUGE) IN POUNDS PER SQUARE INCH
NOMINAL PIPE DIAMETER, IN INCHES
DROP IN PRESSURE
A GRAPHIC SOLUTION OF
D'ARCY'S FORMULA
FOR THE TRANSMISSION OF
COMPRESSED AIR IN PIPES
BY NATHANIEL HERZ.

any elevation may be found by either of the following equations:

(6) $$\text{Log } P_a = 1.1673 - \frac{h}{122.4\,T}$$

(7) $$P_a = 0.4931B(1 - 0.0001\,(F - 32))$$

Where h = altitude in feet.

T = absolute atmospheric temperature (460 + F°).

P_a = atmospheric pressure, pounds per square inch.

F = Fahrenheit temperature in degrees.

B = barometer in inches.

Thus for an elevation of 8000 ft. and a temperature of 60°F., $\text{Log } P_a = 1.1673 - \frac{8000}{122.4\,(520)} = 1.1673 - 0.1257 =$ 1.0416, or the log of 11 as the nearest number.

The effect of lessened atmospheric pressure on a compressor is to reduce the quantity of air delivered, as compared with operation at sea-level. With constant temperature the volume of a definite weight of air varies with the absolute pressure. If P_s = absolute (atmospheric) pressure at sea-level = 14.7, the percentage at tion does not fall off as rapidly as the capacity is reduced. The ratio of compression for 100-lb. gauge at 8000 ft. elevation is $\frac{(100 + 11)}{11} = 10.1$, as against 7.8 at sea-level. A greater ratio of compression means a higher final temperature for the air in the cylinder, and this requires more power for compressing. The heated air tends to expand and thereby offers greater resistance to the piston. At an elevation of 15,000 ft. the reduction in capacity, when compared with conditions at sea-level, is about 42%, but the decrease in power required is only about 25%.

The weight of a cubic foot of air at any pressure and temperature can be found by means of the formulas given below.

(8) $$w = 2.708\left(\frac{P}{T}\right)$$

(9) $$w = 1.325\left(\frac{B}{T}\right)$$

where w = weight of air in pounds per cubic foot.

P = absolute pressure.

T = absolute temperature.

B = barometer in inches.

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The weight of a cubic foot of air at sea-level and 60° F. $= 2.708 \left(\frac{14.7}{520}\right) = 0.0766$ lb., and at 8000 ft. elevation $= 2.708 \left(\frac{11}{520}\right) = 0.0572$ pounds.

When calculating the free-air requirements of rock-drills, it is necessary to reduce quantities to equivalent cubic feet of free air at sea-level, a figure usually given by manufacturers in their catalogues. For drills operating at sea-level, but under different pressures, the ratio of the cubic foot of free air consumed would be equal to the ratio of the final absolute pressures used. Thus, for a drill consuming 80 cu. ft. of free air at 90-lb. gauge, the final absolute pressure is 104.7 lb., and for a similar drill operating at 100-lb. gauge, the final absolute pressure is 114.7 lb., and the ratio of two is $\frac{114.7}{104.7} = 1.19$. The second drill requires $80 \times 1.19 = 95.2$ cu. ft. free air. In case it is desired to determine the free-air consumption of a drill operating at 90-lb. gauge and at an elevation of 8000 ft. use the equation.

$$R = \frac{p_a(P_a + P_g)}{P_a(p_a + p_g)} \tag{10}$$

where R is the ratio of free-air consumption at a given altitude to that at sea-level. The small letters are for sea-level conditions, the capitals are for conditions at any elevation, and the subscripts are for atmospheric and gauge-pressures respectively. For the first drill mentioned above, $R = \frac{14.7(11 + 90)}{11(14.7 + 90)} = 1.19 \times 80 = 103.2$ cu. ft. of free air required at 8000 ft. elevation to equal 80 cu. ft. at sea-level.

An all too common cause of loss of power in the use of compressed air is caused by the installation of pipe-lines of too small a diameter. Even though the main air-line may be large enough, the branch lines and pipes to the drills are often so small that a 10 to 25% loss in power is experienced. In order to keep friction-losses within a reasonable limit, the velocity of the air should not exceed 20 to 25 ft. per second. If a 3-in. piston-drill were supplied with air through a 1-in. pipe, the velocity of the air would be over 50 ft. per second, and the resultant drop in pressure would be nearly 10 lb. for a 100-ft. length of pipe. On the other hand as an example, two drills were supplied with air through a pipe-line 10,000 ft. long in which the velocity of the air was only 3.5 ft. per second. The total drop in pressure was only 0.002 lb. Chart No. 2 shows the loss in pounds for 100 ft. of pipe when conveying air at 90-lb. gauge-pressure through small pipes. Evidently it is better to use a 1¼-in. or a 1½-in. pipe than the 1-in. which is often installed. In Vol. 44, Trans. A. I. M. E. (1913), Nathaniel Herz gives a graphic solution of D'Arcy's formula for computing the size of air lines.

$$V = c\sqrt{\frac{d^5(p_1 - p_2)}{wL}} \tag{11}$$

V = cubic feet compressed air delivered at final pressure.
c = experimental coefficient.
d = diameter of pipe in inches.
L = length of pipe in feet.
w = weight in pounds per cubic foot of air at pressure p_1.
p_1 and p_2 = initial and final gauge-pressures respectively.

TABLE OF VALUES OF c

Size of pipe	Value of c	Size of pipe	Value of c
1-in.	45.3	7-in.	60.3
2-in.	52.6	8-in.	60.7
3-in.	56.5	9-in.	61.0
4-in.	58.0	10-in.	61.2
5-in.	59.0	11-in.	61.8
6-in.	59.8	12-in.	62.0

Chart No. 3 gives a graphic solution of this formula. To use the chart, find on the left hand margin the quantity of compressed air to be delivered, then pass horizontally to the diagonal line for the length of pipe-line, project vertically to intersect the diagonal for the initial gauge-pressure, then across horizontally to the right to the heavy vertical line upon which the initial gauge-pressures are printed. Use this point as a pivot, and swing a straight-edge to cut the lines for size of pipe and the drop in pressure. The pressure-drop in various sizes of pipes can thus be quickly ascertained. The cubic feet of compressed air to be delivered is found by dividing the cubic feet of free air required by the ratio of the final absolute pressure in the pipe to the atmospheric pressure. If the drop in pressure is large, it may be advisable to re-calculate the cubic feet of compressed air delivered. The method of using the chart may be reversed to find the maximum volume of air that may be handled in a given line.

RELATIVE CARRYING CAPACITIES OF PIPES

Size	1	1¼	1½	2	2½	3	3½	4	4½	5	6
1	1.0	0.48	0.27	0.14	0.07	0.05	...	...	...	...	...
1¼	2.1	1.0	0.55	0.29	0.16	0.10	0.06	...	...	...	...
1½	3.7	1.8	1.0	0.53	0.29	0.18	0.11	0.08	...	...	...
2	7.14	3.4	1.9	1.0	0.53	0.33	0.21	0.14	0.10	...	...
2½	13.4	6.3	3.5	1.9	1.0	0.63	0.40	0.27	0.20	0.15	...
3	21.4	10.3	5.7	3.0	1.6	1.0	0.67	0.43	0.32	0.23	0.15
3½	...	16.1	9.0	4.7	2.5	1.5	1.0	0.68	0.50	0.38	0.23
4	...	...	13.1	6.9	3.7	2.3	1.4	1.0	0.71	0.56	0.34
4¼	...	...	...	9.6	5.0	3.1	2.0	1.4	1.0	0.77	0.47
5	...	...	...	...	6.7	4.4	2.6	1.8	1.3	1.0	0.63
6	...	...	...	...	...	6.5	4.3	2.9	2.1	1.6	1.0
7	...	...	...	...	...	...	6.5	4.4	3.2	2.4	1.5
8	...	...	...	...	...	...	...	6.5	4.7	3.5	2.2
10	...	...	...	...	...	...	...	...	8.3	6.3	3.9
12	...	...	...	...	...	...	...	...	...	10.3	6.3

When pipe-lines are being constructed care should be taken that white lead or other cementing material is not used in such excess that it is forced into the pipe, thereby obstructing the passage of the air. All joints should be tightly screwed together, and blow-off or drain-valves should be placed at low points so that accumulated water can be drawn off. A pipe-line can be put together so that no noticeable leakage will occur. One of the longest lines in the world, 120 miles in length, is said to have been perfectly tight under a pressure of 600 pounds.

Loss of power is not synonymous with loss of pressure. Where there is a decrease in pressure there is an increase in volume, and the resultant power-loss is less than the loss of pressure. Since the air in a transmission line is at atmospheric temperature, the assumption that it will expand according to isothermal laws is justifiable. The power in the air entering the pipe is there-

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fore $P_1 V_1 \log_e r$, and at the end of the line it is $P_2 P_2 \log_e r_2$, and the efficiency of the transmission of power equals the ratio of the two quantities. Now $P_1 V_1 = P_2 V_2$ and, together with the base e, can be eliminated from the expression. The efficiency of transmission is then

$$(12) \qquad E = \frac{\log r_2}{\log r_1}$$

where r_2 and r_1 are the ratios of compression at the discharge and intake-ends of the pipe respectively.

Example: what diameter should be used for a line that is to transmit 4000 cu. ft. free air per minute, com-

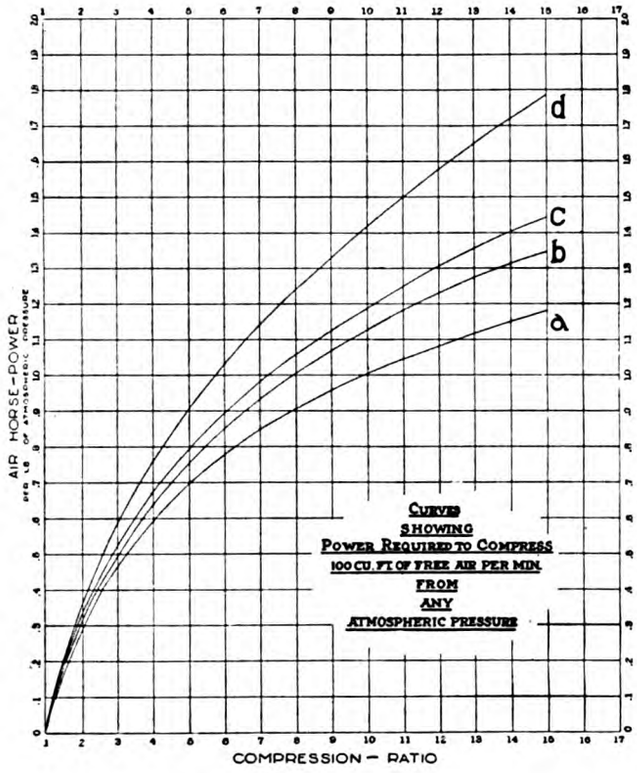

CHART NO. 1

method of determining the cubic feet consumed is to use two steel tanks from 2 to 3 ft. in diameter and from 4 to 6 ft. high. The tanks are placed close together, and the bottoms are connected by a 3 or 4-in. pipe. A pipe is run from the top of each tank to a four-way valve, which is also connected to the air-main and to the line running to the drills. A water-glass should be placed on the

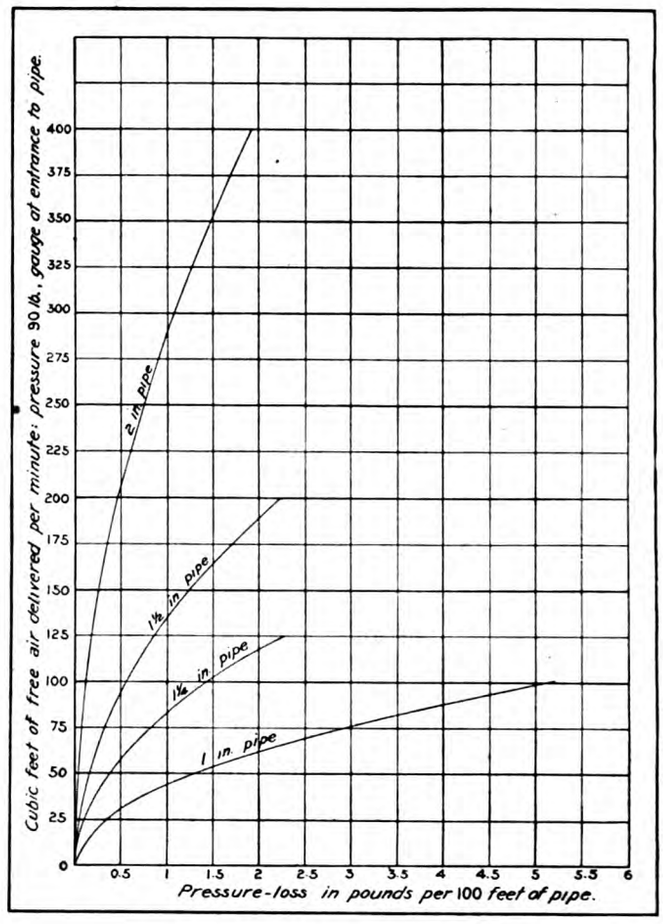
Cubic feet of free air delivered per minute: pressure 90 lb., gauge at entrance to pipe.
2 in. pipe
1½ in. pipe
1¼ in. pipe
1 in. pipe
Pressure-loss in pounds per 100 feet of pipe.

CHART NO. 2

The cubic feet of free air required by various sizes of rock-drills is given in the accompanying table. The figures represent good average practice.

Cubic feet of free air required by piston-drills at sea-level. Pressure, 90 lb. gauge.

Size of drill, in....	2	2¼	2½	2¾	3	3¼	3½	3⅞	4¼	5
Cu. ft. per minute..	70	87	95	118	126	140	152	160	210	250

Hammer-drills require from 15 cu. ft. for light work, such as hitch-cutting, to 65 or 80 cu. ft. for the large sizes. In a mine using a large number of drills, all the drills are never running at the same time. A factor for estimating the number of drills that would probably be in operation at the same time is as follows:

Number drills...	2	3	4	5	6	7	8	9	10
Factor	1.8	2.7	3.4	4.1	4.8	5.5	6.1	6.7	7.3
Number drills.....	11	12	15	20	25	30	35	40	
Factor	7.8	8.4	10.3	12.8	15.1	17.3	19.7	22	

The air-requirements of different drills vary so that it is advisable to have some means of measuring the air actually used. A simple and sufficiently accurate outside of each tank. Marks should be placed on these glasses at the top and bottom so that the tanks can be filled and emptied to these marks and the volume, in cubic feet, required to do this can be calculated. Both tanks should be provided with pressure-gauges. To use the tanks, first fill them half full of water. Air from the supply-line is then admitted through the four-way valve until the water in one tank is lowered to the bottom mark; the other tank is then full of water. The valve is now reversed and air is admitted to the second tank, forcing water into the first one and displacing the air contained, which goes out through the valve to the drills. The cubic feet of compressed air required can be calculated from the number of times the tanks are filled and emptied. The equivalent cubic feet of free air can be determined from the equation $v = \frac{PV}{P}$, where v is the required volume of free air, p is atmospheric pressure, P equals absolute pressure in tanks, and V is the volume of compressed air handled.

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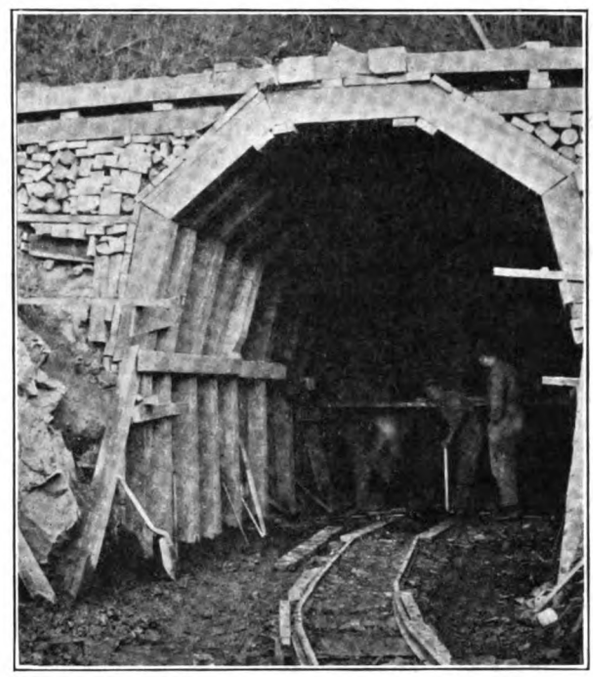
Methods of Driving Pine Mountain Tunnel and Comparison With Other Tunnels

By H. DEVEREUX*

The Pine Mountain tunnel is being driven in Marin county, California, at a point about three miles west of Fairfax. The tunnel is part of the proposed system for the Marin Municipal Water District, connecting the Lagunitas water-shed with the water supply system for the eastern part of Marin county. It is of horse-shoe section, 8 by 8 ft. net, inside the concrete lining. The total length is 8700 ft., of which about 600 ft. near the two portals will have a 12-in. concrete lining, and the remaining 8100 ft., a 6-in. lining. The quantities per lineal foot are as follows: excavation, 3 cu. yd., theoretical amount of concrete in 12-in. lining, 1.2 cu. yd.; concrete in 6-in. lining, 0.6 cu. yd. The actual quantities of concrete will be about 35% greater, on account of overbreakage. The work is being done under the direction of M. M. O'Shaughnessy, consulting engineer for the district, A. R. Baker, engineer for the district, and C. T. Broughton, resident engineer on the work. The contract was awarded early in December 1916 to McLeran & Peterson, of San Francisco, at $257,400 for the entire work, or $29.70 per lin. ft. for driving and lining the tunnel. Work was commenced in the middle of December. Hand-drills were used until about February 1, machine-drills since that time. The actual cost of driving has been about the same for both methods, but the machine work is much more rapid. Up to May 15 about 2000 ft. of progress was made on the east end, and 1000 ft. on the west end. Concreting commenced about June 1. The maximum progress in driving for any one month has been 568 ft. in the east heading, or 19 ft. per day. The average progress since the machine drills were installed has been 13 ft. per day in the east end, and 10 ft. in the west end.

Some other American tunnel records are as follows: On the Sheep Creek tunnel in greenstone and slate the maximum progress was 661 ft. per month and the average for a period of six months, 596 ft. per month. At the Alaska-Gastineau mine, an 8 by 10-ft. tunnel was driven 8800 ft. at a rate of 544 ft. per month. The maximum monthly progress in the Roosevelt tunnel, which had a 6 by 10-ft. section and was driven in Pikes Peak granite, was 435 ft., and the average was 292 ft. The Elizabeth Lake tunnel on the Los Angeles Aqueduct was driven 604 ft. in one month through black shale. The section was 12 by 13 ft. The Red Rock tunnel, also on the Aqueduct was driven 1061 ft. in one month through cemented sandstone. An 8 by 8-ft. tunnel for the Arizona Copper Co. was driven 799 ft. in one month through porphyry. The average monthly progress was 669 ft. The Gunnison tunnel, 6 by 10½ ft., was driven 824 ft. in one month through soft limestone. The Mt. Royal tunnel, 8 by 12 ft., was driven 810 ft. in one month through limestone. An 8½ by 9½-ft. tunnel at Mammoth, California, was driven 395 ft. in one month. The average progress was 316 ft. The



EAST PORTAL OF TUNNEL

Laramie-Poudre tunel, 7½ by 9½ ft., was driven 653 ft. in one month through granite. The average was 525 feet.

The power-plant for the Pine Mountain tunnel is on the Bolinas road about three miles west of Fairfax. The east portal is about 1000 ft. from the power-house. The west portal is nearly two miles southwest from the power-plant. Until recently the west portal could be reached only by pack-train, but the trail has recently been improved so that light loads can be hauled over the mountain.

The compressor-plant consists of three 25-hp. Fairbanks-Morse Y-type semi-diesel engines, and three 8 by 8-in. Sullivan compressors. The pressure maintained at the compressor is 100 lb. per sq. in. A study of records on 25 other long tunnels shows that this is the average pressure maintained. The lowest was 85 lb., on the Strawberry tunnel, and the highest, 120 lb. on the Laramie-Poudre. Six tunnels used 100 pounds.

*1990 Fell street, San Francisco.

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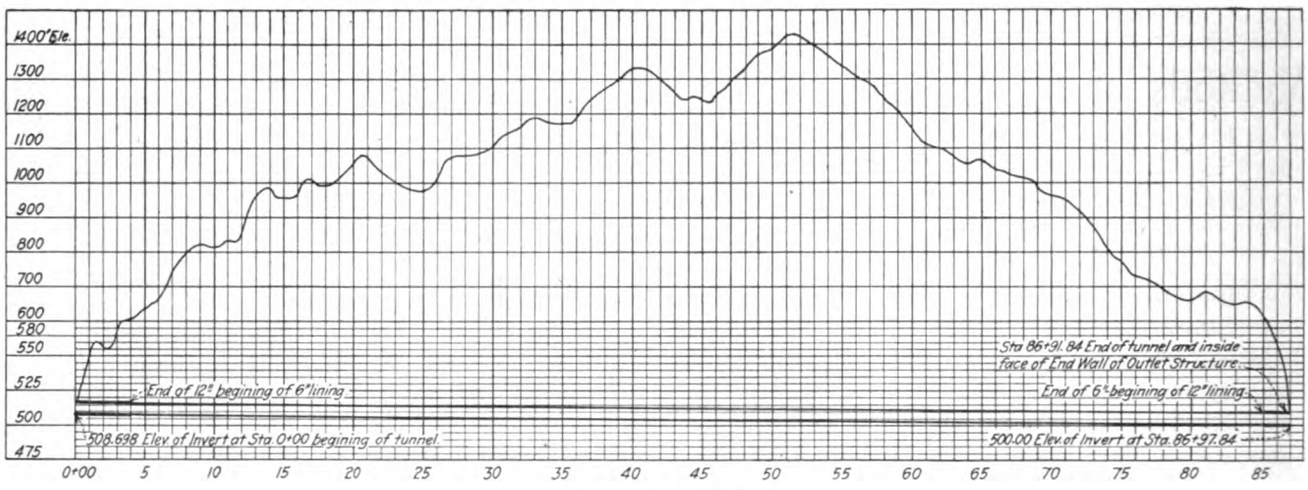


PROFILE OF TUNNEL

Air is conveyed through a 3½-in pipe, 1000 ft. to the east portal, and 10,000 ft. to the west portal. Three hundred cubic feet of free air per minute is supplied, which is sufficient to run three drills and also the forges. The loss of pressure at the west end does not exceed 2 lb. Records on nine long tunnels show capacities of plant ranging from 247 to 868 cu. ft. of free air per minute, with an average of 550 pounds.

The D'Arcy-Cox formula for the conveyance of compressed air in pipes is

$$D = \frac{c\sqrt{d^5}}{\sqrt{L}} \times \frac{\sqrt{P_1 - P_2}}{W_1}$$

Where

D = volume of compressed air in cubic feet per minute discharged at final pressure.

c = a coefficient, ranging from 45 for a 1-in. to 60 for a 6-in. pipe.

d = diameter of pipe in inches.

L = length of pipe in feet.

P_1 = initial gauge-pressure in pounds per square inch.

P_2 = final gauge-pressure in pounds per square inch.

W_1 = density of the air or its weight in pounds per cubic foot.

TABLE I

Diameter of pipe, inches	Value of $c\sqrt{d^5}$
1	45
1¼	105
1½	155
2	300
2½	530
3	875
3½	1300
4	1860
5	3300
6	5270

TABLE II

Values of $\frac{\sqrt{P_1 - P_2}}{W_1}$

Final pressure, lb. per sq. in.	Losses of pressure $P_1 - P_2$ in pounds							
	1	2	3	4	5	6	8	10
70	1.5	2.1	2.6	3.0	3.3	3.6	4.1	4.5
80	1.4	2.0	2.4	2.8	3.1	4.0	3.9	4.3
90	1.3	1.9	2.3	2.7	3.0	3.2	3.7	4.1
100	..	1.8	2.2	2.6	2.8	3.1	3.6	3.9

Example: Given a 3½-in. pipe, 10,000 ft. long, how many cubic feet of air per minute at an initial pressure of 90 lb. can be transmitted, with a loss of pressure of not more than 2 pounds?

From Table I, opposite a 3½-in. pipe, find 1300.

Square root of 10,000 = 100.

1300/100 = 13

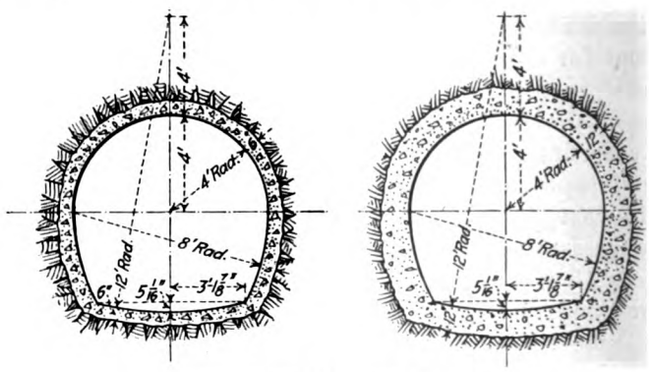
From Table II, for drop of 2 lb. at 90 lb. final pressure, find 1.9.

$13 \times 1.9 = 23.7$

90 lb. + 14.7 (atmospheric) = 104.7

$\frac{23.7 \times 194.7}{14.7} = 170$ cu. ft. (approx.) of free air per minute.

In using Table II, it will be noted that the initial and final pressures are taken as the same. Should greater



STANDARD SECTIONS FOR TUNNEL

refinement be required, interpolate for the difference, remembering, however, that a slight leak in the line may change the results.

Three No. 18 Leyner drills with a 1¼-in. chuck, 24-in. feed, and six sets of 1¼-in. hollow steel from 24 to 96 in. long, are used. There is an 18-gal. water-tank and an air-line manifold. The drills are mounted on horizontal bars. Jackhamers are used for trimming. On other long tunels, preference was about equally divided between vertical columns and horizontal bars.

The duty of a No. 18 Leyner drill in this tunnel is 5 ft. of hole per hour, using 1000 cu. ft. of free air at 100 lb. pressure per lin. ft. of hole drilled. The cost of

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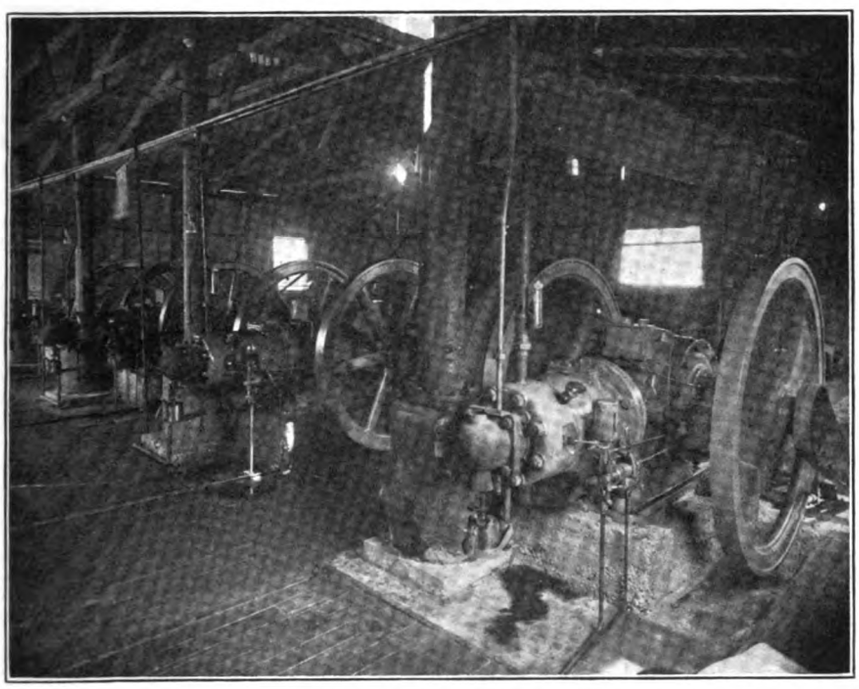
drilling, including bonus is $0.20 per ft. This estimate allows for delays.

The cost of fuel and lubricating oil for a 135-day run was as follows: 11,000 gal. fuel-oil, 24 Baumé gravity, at $0.032 per gallon = $352; 250 gal. valvoline, strained and used twice, at $1.35 = $324; hauling, three miles from railroad, at $0.005 per gallon, = $55; total, $731.

The plant was run continuously and 62½ hp. was developed. This gives a cost of 0.36c. per hp. hour for fuel and lubricating-oil. This amount of power is sufficient for three drills and two forges. The cost of labor at the power-house is $320 per month. During March the total progress in both headings was 854 ft., and the cost for power was $0.65 per ft., $0.29 for fuel and $0.36 for labor. A 25-hp. Fairbanks-Morse Y-type engine has just been installed to operate a 220-volt, 25 kilowatt generator, which will be used to run a plant for lighting the tunnel and a rock-crusher for crushing aggregate for the concrete lining.

Purchased electric power on four other long tunnels cost from $1.65 to $2.15 per lin. ft. or an average of $1.90. Electric power generated on the work for the Elizabeth Lake tunnel on the Los Angeles Aqueduct cost $5.25 per ft., and on the Strawberry tunnel, where it was transmitted a distance of 23 miles, $5.50 per ft. On another tunnel, where steam was used, with wood for fuel, the cost for power was $2.50 per ft. Where steam was used with crude-oil for fuel, the cost was $2.28 for fuel, and $0.80 for labor.



INTERIOR OF COMPRESSOR PLANT

For ventilation, 1000 ft. of 10-in. pipe has been laid at each heading, reducing to 8-in. for the remainder of the distance. This pipe has been found to be too small, and is to be replaced with a 12-in. pipe, using a blower working at a pressure of 4.5 lb. per sq. in. To clear a tunnel of four air in 15 minutes, which is the maximum time that should be allowed for delays after blasting, requires a capacity of 4000 cu. ft. of air per minute. For respiration allow 75 cu. ft. per man per minute, and 150 cu. ft. per animal. The average rated capacity of ventilating apparatus used on 16 long tunnels was 3400 cu. ft. per minute. The size of the ventilating-pipe ranged from 10 in. for the Carter and Mission tunnels, to 18 in. for the Elizabeth Lake and 19 in. for the Central tunnel. Where light-gauge sheet-metal pipes are used for ventilation, it is advisable to build a small bulkhead of track-ties in front of the pipe before blasting in order to prevent collapse of the pipe.

Table III gives the diameter of pipe in inches required to deliver 4000 cu. ft. of free air per minute for lengths of pipe from 1000 to 14,000 ft., and for pressures from 1 to 6 pounds.

TABLE III

Length of pipe, ft.	Pressure, lb. 1	2	3	4	6
1,000	12	10	..	..	..
2,000	14	12	11	10	..
3,000	15	13	12	11	10
4,000	16	14	13	12	11
5,000	17	15	13½	12½	11½
6,000	..	15½	14	13	12
8,000	..	16	15	14	12½
10,000	..	17	15½	14½	13
12,000	..	..	16	15	13½
14,000	..	..	..	..	14

For illumination, acetylene lamps on the men's caps and candles have been used, but as already noted, an electric-lighting plant has now been installed. Acetylene lamps have been used on several long tunnels, small lamps being used on the men's caps and larger stationary lights being placed 150 ft. apart along the tunnel. This is an economical method of lighting. Electric lights are usually employed where electric hauling is done. The cost of lighting the Mile Rock tunnel with electricity was $0.50 per ft. of tunnel. In wet tunnels, electric lights are uncertain.

The rock encountered so far in the east end of the tunnel is sedimentary with intrusive igneous rock. On the west end there is Franciscan sandstone, black serpentine, and hard boulders, with some diabase. The rock at the west end is harder than at the east end. The number of holes per round at the east end is 9 to 14, and 14 to 16 at the west end. Six feet of hole is drilled per round, the wedge-cut system of arrangement being used. Forty per cent L. F. gelatine powder is used, supplied by the Hercules Powder Co. In the east end, 9 lb. of powder, 19 ft. of fuse, and 4 caps are used per lin. ft. of progress. In the west end, 15 lb. of powder, 26 ft. of fuse and 4 caps are required.

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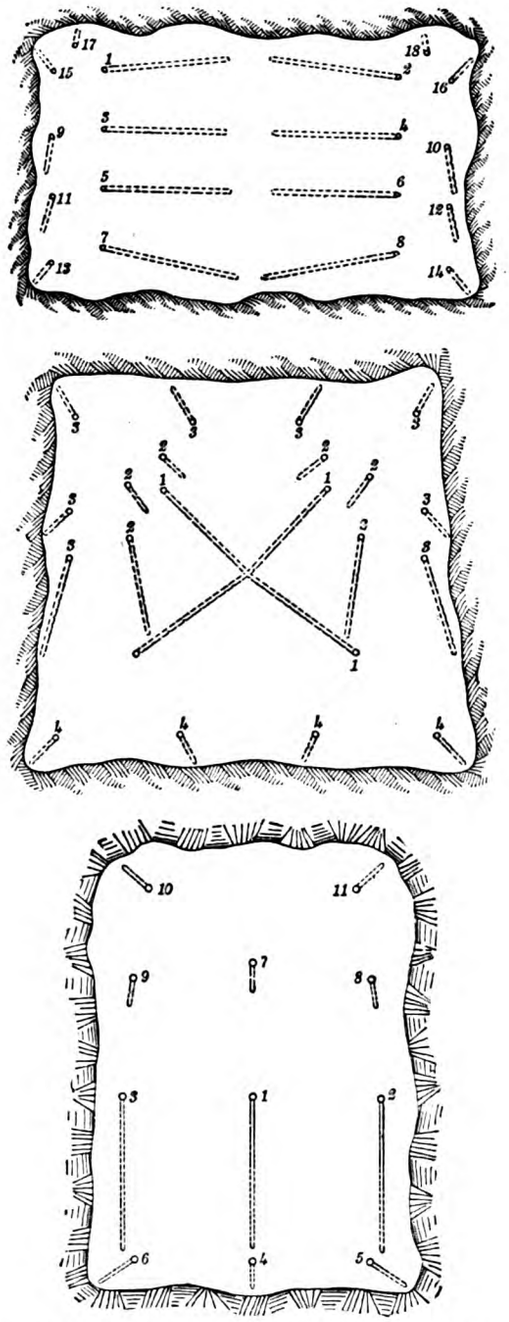
Records of other long tunnels show that the wedge-cut was used in 19 instances, the pyramid-cut in 4, and the bottom cut in 7. An analysis of the depth of holes generally used in American practice, would lead one to infer that the most successful driving was secured when the average depth of the holes was from 60 to 80% of the



WEDGE-CUT, PYRAMID-CUT, AND BOTTOM-CUT SYSTEMS
From Brunton and Davis, Modern Tunneling)

width of the heading for wedge and pyramid cuts, and 60 to 80% of the height for the bottom cut. In cases where deeper holes had been used, and the depth of holes was later reduced according to the above rule, there was an increase of speed of as much as 20% and a decrease of powder used of as much as 25%. The number of holes per round is dependent upon the character of the rock. An approximate rule for sedimentary formations is one hole to 5 or 6 sq. ft. of face of heading, and in igneous formations, one hole to 2.5 to 4 sq. ft. of face.

The amount of explosive used in small tunnels ranges from 3.5 to 10 lb. per cu. yd. of material removed. Bottom-cut holes appear to require more powder than pyramid or wedge-cut holes. As regards percentage of gelatine powder used, practice has ranged from 40% in six tunnels to 100% in the Roosevelt tunnel, which was driven through Pikes Peak granite. Loading the bottom of the hole with 80 to 100% powder and the rest with 40 to 60% has given good results in a number of cases. On the Grapevine division of the Los Angeles Aqueduct 40 and 60% ammonia powder was used. There was comparatively little difference in the effect of the two grades. Ammonia powders are affected by moisture and are not suited to wet tunnels. The gases from the ammonia are disliked by the workmen.

It is best to place the cap near the top of the charge and tamped with powder, although many powder-men prefer placing the cap at the bottom of the hole. A cap has recently been placed on the market that acts like a time-fuse, enabling the cut-holes, relievers, back-holes, and lifters to be fired at intervals and in rotation by an electric battery.

On the east end there are two drillers and one helper per shift, and one driller and one helper per shift on the west end. Three shifts are worked and as many as five rounds or 30 ft. of progress has been made in 24 hours, requiring 150 ft. of drill-hole per drill for each 24 hours. Four shovelers are employed on a shift in each end, two working at any one time and two resting. They handle from 10 to 15 cu. yd. per man per shift. The shovelers use square-pointed shovels, and shovel from steel floor-plates, ¼ in..by 4 by 6 feet.

The material is transported by mules in turn-table end-dump cars of 25 cu. ft. capacity. When the work has progressed so far that mules cannot handle the material economically, it is proposed to remodel White or Stanley steam-automobiles to do the hauling. Such remodeled machines are now being used successfully on the Twin Peaks tunned. At the east end the material is dumped close to the portal. On the west end it has to be hauled for some distance. The track has an 18-in. gauge and is laid with 27 lb.-rails. The original intention was to use 25-lb. rail, but it happened that a quantity of 27-lb. rail was available.

There seems to be no established practice regarding types of cars or track for this class of work. On 7 tunnels, turn-table end-dump cars were used, on 4 common end-dump cars, on 7 side-dump cars, and on 4 rocker-dump cars. On the Los Angeles Aqueduct, rocker-dump cars with a capacity of 32 cu. ft. were used, while on the Catskill Aqueduct side-dump cars with a capacity of 40 cu. ft. were employed. Sizes of cars varied from 1 ton up to 40 cu. ft. The smaller cars are more convenient since in narrow tunnels the empty cars can be made to pass the loaded ones by simply tipping the former off the track. Weights of rails have ranged from 12 to 36 lb., and gauges from 18 to 36 in. The final report of the Los

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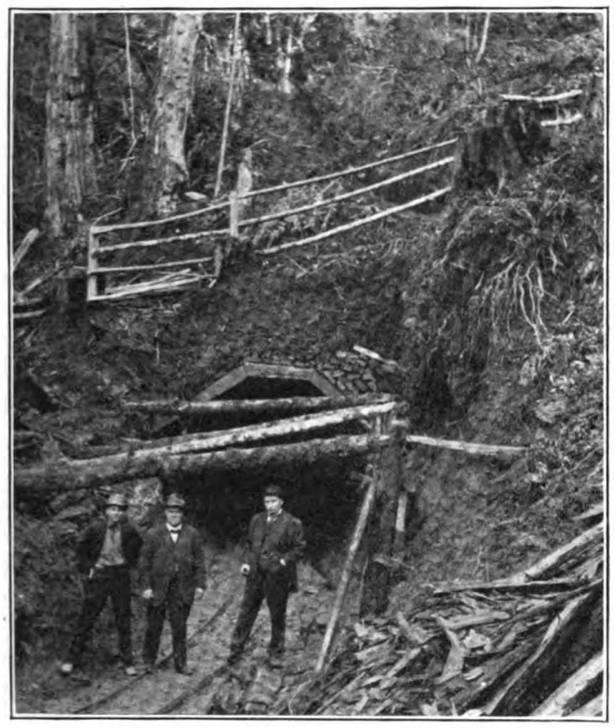
Angeles Aqueduct recommends a 25-lb. rail where concrete is to be hauled. Where heavy cars are used, a mechanical dumping-system is required.

Considerable trouble has been experienced at the west end of the Pine Mountain tunnel on account of water. There are 'pockets' of water that give a large flow for a few days and then run dry, making pumping a difficult matter. This has been remedied by cutting a ditch to drain the water back from the face of the tunnel. This matter of drainage is frequently a considerable item of expense in long tunnels. The cost of pumping at the Mile Rock tunnel was $1.30 per lin. ft. At the east end of the Strawberry tunnel, the wet end, the cost of pumping was $1.36 per lin. ft. At the Roosevelt tunnel a drainage ditch 4 by 6 ft. was excavated at a cost of $1.10 per ft. If an 8 by 8-in. ditch is carried under the track in the middle of the heading, lined on the sides and covered with a 2-in. plank at an elevation of 18-in. below grade at the same time as the rest of the drilling is done, the water-problem at the lower end of a tunnel will be easily and economically handled. A similar arrangement is advisable at the upper end of the tunnel, whenever the grade is such that the ditch need not be over 4 or 5 ft. deep at the portal.



WEST PORTAL OF TUNNEL

So far, but little timbering has been required. About 10% of the tunnel has been side and top-lagged, while for about 5%, timber sets in the arch only have been used with the top-segments lagged. In the first 2000 ft. of tunnel 20,000 ft. B.M. of timber has been used, or 10 ft. B.M. per foot of tunnel. The cost of placing timber full-lagged is about $15 per M.B.M. Where arch-sets and crown-bars are used the cost will be greater, about $25 per M.B.M. Where timber is cut in the woods nearby a man can cut and frame 1000 ft. B.M. in 4½ days.

The overbreakage thus far has been small, not exceeding 35% of the net area of the concrete section. On the east end, the ground is being drilled to the full section, on the west end to about 80% of the full section, requiring trimming along the entire length in the latter case. On the Los Angeles Aqueduct some tunnels were driven and trimmed so closely that the excess yardage did not exceed 15 or 20% of the theoretical yardage of concrete, but the cost of trimming amounted to as much as $2 per lin. ft. of tunnel. The conclusion with regard to hard-rock tunnels was that the excess yardage of concrete lining should not be over 30 to 40%. When a cubic yard of concrete in the net section was required per lin. ft. of tunnel, a 100% excess was valued at $6 to $7 and a 30% excess at $1.80 per lin. ft. It was found to be the best practice to excavate the sub-grade at the start so that the top of ties is at the bottom of the theoretical sub-grade, so as to avoid expensive trimming and delays when the concrete lining is placed. In the Mile Rock tunnel the theoretical quantity of concrete per lin. ft. of tunnel was 1.6 cu. yd., and the actual 2 cu. yd., or a 25% excess.

The cost of driving the Mile Rock tunnel was $4.75 per cu. yd. or $27 per lin. ft. of tunnel. The cost of lining was $9 per cu. yd. of concrete, or $18 per lin. ft. of tunnel. In general the cost of lining small-section tunnels where compressed air is used to make and place the concrete, and wooden forms are employed, is $1.60 per lin. ft. for forms and $1.40 per cu. yd. for labor and royalty in placing concrete, plus the cost of materials, aggregate, and power, and the distributed general expense and liability insurance. On the Mile Rock tunnel the overhead for general expense and insurance was 15% of the total cost to the contractor. On the Pine Mountain tunnel the liability insurance and bond are carried by the water district and do not appear in the contract price.

The following is the scale of wages paid on the Pine Mountain tunnel

Drillers	$3.75	Dump-men	$3.00
Helpers	3.00	Foremen	6.00
Shovelers	3.25	Compressor-engineers	3.50
Teamsters	3.00	Pipe-men	3.00
Blacksmiths	4.00	Packers	3.00
Helpers	3.00	Common labor	2.50

The maximum monthly progress has been 568 ft. or 19 ft. per day. For this rate of progress, which was at the east end, the cost per lin. ft. to the contractor is as follows:

Drilling	$1.67	Teaming	$0.30
Shoveling	1.90	Packing	0.25
Hauling	0.67	Miscellaneous plant, pipe-line, track	2.00
Dumping	0.48	Heavy plant, engines and compressors	1.00
Blacksmith	0.37	Drill steel, repairs	0.30
Pipe-men	0.16	Timbering, material	0.20
Powder	1.80	Timbering, labor	0.12
Power	0.65		
Bonus	2.00	Total cost per foot	$16.12
Construction and maintenance of roads and trails	0.25		

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A bonus of $0.25 per man per ft. is paid for each additional foot over 14 ft. per day, to all men who remain during the month. The cost at the west end is about the same as at the east end. The rate of progress is less, but on the other hand there is no bonus. Assuming that the excavation runs 3 cu. yd. per lin. ft. of tunnel, the cost per cu. yd. is approximately $5.40.

Other miscellaneous costs are as follows: Cost of camp-buildings, etc., $25 per man for a 70-man camp. The cost of laying the 3½-in. pipe for the compressed-air line over the mountain was $0.08 per ft. for distribution, and $0.04 for laying, a total of $0.12. The cook-house, which cares for 40 men, uses one barrel of fuel-oil in 8 days.

THE TRAFFIC-CENSUS AND ITS APPLICATION TO THE DESIGN OF STREET HIGHWAYS*

By D. B. GOODSELL†

In fixing the width of any roadway-surface, the number of lines of traffic to be accommodated should be given consideration. The statement has been made that where a vehicle has to turn from the hard surface of a road to an earth shoulder oftener than five times in a mile, it is cheaper to construct the additional width of road-surface that may be required, and is far safer.

The necessary amount of clearance that a vehicle must have in order to pass safely depends on the speed. The average width of vehicles in New York city has been found to be 6 ft. 9 in., large trucks occupying as much as 8 or 9 ft. At slow speed, say 10 miles per hour, with the average width, the width of a single line of automobile traffic, including clearance, would be 8 ft., and at fast speeds 9 ft. or more. On Fifth avenue, in New York cit, there are six lines of automobile traffic occupying 55 ft., the speed being between 5 and 8 miles per hour. It is obvious that if the roadway had been made, say, 3 ft. narrower, another line of travel—or possibly two—would have to be sacrificed. The width of the Fifth Avenue roadway was originally 40 ft., accommodating four lines, with too much clearance. It was widened 15 ft., and now takes six lines, with a safe clearance. It is obvious that great congestion would have occurred, and much inconvenience to the public, had the street continued with only four lines of traffic and its excessive width.

On a suburban or country road accommodating motor traffic, the additional clearance required by an overtaking car should be considered. When moving at, say, 25 miles per hour, at least 4 ft. of free way should be given the overtaken car to avoid accident due to unexpected deflection from its course. A width of 20 ft., for this reason, is better than 18 ft. for two lines of travel, and 30 ft. is ample for three lines.

In the borough of Manhattan, a realization of the necessity for widening the narrow cross-town roadways of the mercantile district, and some of the north and south avenues as well, began to bear fruit in 1911, and has resulted since then in the widening of 14 streets and avenues 35,012 ft. in length. Apparently the work has just been begun. On all of these streets a ten-hour census of the vehicular and pedestrian traffic was taken, and resulted in bringing to light, places of unexpected congestion and afforded clues as to how the traffic can be diverted. It was found that, where the maximum number of vehicles per foot of width per minute exceeded 0.5, there was such serious congestion that a remedy needed to be applied. It was also found that where the maximum number of pedestrians per foot of width per minute exceeded 5, they flowed over the sidewalk into the roadway. Where both these conditions obtained, the street would need to be widened. So far, this difficulty has been met by clearing the sidewalks of stoops, railings, court-yards, areas, and other projections, thus affording additional space for pedestrians, and then widening the roadway to accommodate the suitable number of lines of travel, provided such widening did not produce an unduly congested condition for the pedestrian-traffic. The traffic-census has supplied the strongest kind of supporting data for promoting legislation for the foregoing work.

The influence of the proportion of horse-drawn traffic on the kind of pavement, its grade, and alignment, should be given weight. In cities with intensive traffic, where more than 75% is motor, sheet asphalt is, in the opinion of the writer, the best pavement. If the traffic is evenly divided between rubber and iron tires, wood block is the best. For slow-moving horse-drawn traffic, amounting to more than 50% of the whole, close-jointed granite blocks are preferable. These limitations are to be applied where traffic-conditions are considered as the controlling factors in forming a decision.

*Part of address presented at convention of the American Road Builders' Association, Boston, Mass., February 1917.

†Assistant engineer, Department of Public Works, New York, N. Y.

Costs of maintenance of small automobiles used on survey work and supervision of construction on the Fort Laramie unit of the North Platte project of the U. S. Reclamation Service are discussed in a recent number of the *Reclamation Record*, by O. T. Reedy. The average cost per month for gasoline, lubrication, supplies, and repairs was about $30, the machines making from 450 to 550 miles per month. This was rather less than the cost of maintaining teams for the same class of work, although one automobile would do the work of two teams, beside effecting a large saving in time of the survey-parties, and therefore of salaries. The service was severe, mainly in country where there were no roads at all, and the records covered both summer and winter months.

Cost of clearing the reservoir-site in the Hetch-Hetchy valley for the city of San Francisco was about $50,000 for 800 acres. The value of the timber recovered almost paid for the clearing.

Maintenance of concrete wharves at Auckland, New Zealand, has cost $0.0033 per ft. per year since 1905, against $0.0767 per ft. per year for wooden wharves.

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REPAIRING CONCRETE SURFACES

The following recommendations have been abstracted from a report prepared recently by the committee on masonry of the American Railway Engineering Association.

The surface to be repaired must first be cleaned thoroughly of all loose material, laitance, and dust, and the clean, rough, sound concrete exposed to receive the patch. The best method of cleaning is by means of a steam-jet.

After cleaning, the surface to be repaired must be saturated with water, so that the old concrete will not absorb water from the new mortar or concrete used in patching. If possible, the surface should be kept covered with water for several hours.

If the repair is to be made on a vertical or sloping surface and is not to be more than 1½ in. thick, the surface of the old concrete should be spattered or splashed with cement grout while it is still wet, following this immediately with a fairly stiff plaster-coat of mortar made of the same proportions of cement and sand as were used in the original concrete, but not richer than 1 cement to 2½ sand. Each plaster-coat should be not thicker than ½ in., and coat should be forced into the surface, but not 'dragged' with a trowel. The surface of each coat, except the final one, should be roughened to give a bond for the next coat. The plastering should preferably begin at the top and progress downward, and only enough time be allowed to permit each coat to receive its initial set before the next coat is applied. The final coat should be finished with a wooden float and only enough water used to finish the surface properly. The repair should be kept damp and protected from sun or frost until completely set.

If a thin repair or 'finish coat' is to be made on a horizontal or nearly horizontal surface, the surface of the old concrete should be covered with thin cement grout, following this immediately with a wet mortar made of 1 part cement and 2½ parts sand or granite screenings and of the full thickness required (not less than ½ in., however). When this mortar begins to take its initial set, it should be floated or troweled to such a finish as may be desired.

If the repair is to be made on a vertical or sloping face and is to be more than 1½ in. thick, it will be advisable to embed dowels into the old concrete, as deeply as the thickness of the proposed patch, and spaced sufficiently close together to anchor the patch firmly to the old concrete. The dowels must be wedged into the old concrete and it will be advisable to fasten wires, metal fabric, or bars to the dowels as an additional safeguard. The patching may then be done with mortar without forms, or with wet concrete supported by forms, depending upon the thickness and the extent of the patch.

If the repair is to be made on a horizontal or nearly horizontal face and is to have considerable thickness, dowels may be used, or the concrete may be reinforced by fabric or bars.

Care must be taken not to have thin edges on patches. To avoid this, it may be necessary to cut out sound concrete around a place to be patched, so as to give deep edges to the patch.

LIGHT RAILROADS IN TRENCH WARFARE

An article in the Toronto, Canada, *Evening Telegram*, by Douglas S. Robertson, discusses the construction and operation of narrow-gauge railroads behind the fighting-lines in France. Standard-gauge lines are built to points at a safe distance in the rear where ammunition and other material is unloaded. Motor trucks are used for a large part of the work of carrying this material to the front, but the cost of transportation is so much higher than with the light railroads that the latter are used as much as possible.

These light railroads are constructed right to the firing-line, shells being delivered directly from the cars to the guns. Each spur is constructed with double loops, so that should shell-fire or other causes destroy one loop, the alternative loop may be used. Steam-driven 17-ton Baldwin locomotives constitute the principal motive power. Most of the cars are like small gondola coal-cars. They are 5 by 17½ ft. and have a capacity of 2½ tons. They are equipped with collapsible sides so that they can be turned into flat-cars. Train despatching is done by telephone.

The customary maximum grade is 1½% and maximum curvature 20°. The lines are usually well ballasted with broken stone or brick, since the transportation of shells requires a firm roadbed. The lines are maintained by repair-trains manned by special forces. Each repair-train has a gasoline-engine, which drives an electric generator, which, in turn operates the various machine-tools required.

A large part of the construction of these lines has been done by Canadian troops, who obtained their training on the prairies of western Canada.

The capacity of freight-cars expressed in barrels of cement is as follows:

Pounds	Barrels
40,000	115
44,000	127
50,000	144
55,000	159
60,000	173
70,000	202
80,000	231
100,000	289

Shippers and consignees can assist in preventing a car-shortage by keeping these weights in mind, and ordering and loading to the full capacity of a car.

The grain-side of a leather-belt should be run next to the pelly, as it adheres more closely than the shaved side, thus enabling the belt to transmit more power.

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Results of Operation of Small Sewage-Disposal Plants*

During the past year the U. S. Public Health Service has been making experiments on the operation of small sewage-disposal plants, consisting of an Imhoff tank and sand bed. Sewage was tested from two sources. The sewage subjected to the most careful test was from 25 people comprising a nurses' dormitory and one residence at the Hygienic Laboratory Testing Station. The sewage flow was 100 gal. per capita daily. The occasional samples of raw sewage gave an average value somewhat over 1,000 parts per million total solids and 177 parts per million for a 24-hour at 20° C., oxygen demand. The other sewage used for testing was from 60 people in a small community in Chevy Chase, Maryland.

It was not considered certain that an Imhoff tank would be adaptable to small plants, for the small-plant sewage would generally be stronger, contain more grease, and its flow be more irregular. It was feared that the presence of large quantities of grease might result in scum-difficulties in the first compartment of the settling-chamber, and that the low night-flow might result in the sewage becoming septic. In addition, the depth of the small tank would, for economic reasons, probably have to be limited to 10 or 12 ft., whereas large tanks are generally 20 ft. or more deep. The depth of the tank is considered by many authorities to have an important effect on the quality of the digested sludge.

The volume of the settling-chamber determines the detention-period. If the detention-period be made too short, the settleable solids will be incompletely removed, and if too long, the sewage will become septic. In the United States the settling-chamber for large tanks is usually made large enough for 1/9 the daily flow, corresponding to a mean detention period of 2.6 hours. It was not considered advisable to design the settling-chamber for a small tank on this basis on account of the wider variations of flow. Instead the daily flow was assumed to take place in 12 hours and the detention period on a basis of three hours. In other words, the settling-chamber was made equal in volume to one-quarter the daily flow, which is equivalent to a mean detention period of 6 hours.

The volume of the settling-chamber is not alone responsible for the degree of removal of settleable solids. The chamber must neither be made so short and wide as to result in short-circuiting through local currents, nor so long and narrow as to approach the proportions of a channel, in which case swirling velocities will occur and hinder sedimentation. The proportions selected must depend largely upon experience, and while considerable experience is available for large plants, this is not so true of small plants. However, the dimensions of the experimental tanks were arbitrarily placed within the range of large-scale experience. The proportions of length, width, and depth were for the Hygienic Laboratory tank, 8 : 3 : 5, and for the Chevy Chase tank, 11 : 1.7 : 3.

The inclination of the partition walls separating the settling-chamber from the sludge-chamber was made 2.6 vertical to 1 horizontal in the Hygienic Laboratory tank and 1.5 : 1 in the Chevy Chase tank. In small plants, steepness of partition-walls is more important than in large plants, because in the latter the attendant may generally be trusted to 'squeegee' the inner surfaces if the accumulated sludge refuses to slide properly towards the slot, whereas in the former no such attendance can be expected. It was for this reason that it was decided to try different inclinations.

In large tanks the clearance of the communicating-slot is 6 to 8 in., while the overlap is 8 in. For small plants a partition inclination of 1.5 : 1, an 8-in. slot-clearance and an 8-in. overlap mean roughly 2 ft. 3 in. vertical distance between the lower edges of the two partitions, which is a considerable proportion of a total depth of 10 or 12 ft., and deducts that much from the sludge capacity. It was decided to reduce the slot-clearance to 5 in. and the slot-overlap to 6 in. There is some question whether a small tank really needs so large a slot-clearance, as it seems likely that the clogging which occurs in Imhoff tanks is often caused by the fact that the passage of settled sludge through the slot is not continuous, but intermittent. The sludge-particles may be conceived as accumulating upon the inclined surfaces until the sliding-thickness is reached, when the mass will begin to slide toward the slot, perhaps developing one or more folds near the slot. The clearance of the slot must be sufficient to pass these sliding-sheets. The thickness of these sliding-sheets and the extent to which they will fold upon themselves will depend upon the inclination and length of the surfaces upon which they develop. Since the length of these inclined surfaces will naturally be less as the size of the tank diminishes, it seems logical to reduce the slot-clearance accordingly.

On account of the tendency of grease in fresh sewage to mix with fecal and other solid matters, and to cause the whole mass to float and become sufficiently dry to prevent decomposition, it was decided to place a horizontal screen at the water-level in the first compartment of the settling-chamber. This would keep the floating solids submerged, and allow them to become waterlogged and sink to the bottom. The mixing caused by the incoming sewage would also tend to separate the grease from the other solids. The introduction of this horizontal screen has apparently been successful. There has never been more than 2 in. of grease under the screen in the Chevy Chase tank and at the Hygienic Laboratory the material which has collected, while more voluminous,

*Part of paper read before the New Jersey Sanitary Association by L. C. Frank, sanitary engineer, U. S. Public Health Service, Washington, D. C.

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has been found to be almost pure grease, the removal of which was not at all objectionable.

Gas-vents were provided on either side of the settling-chambers. At the Hygienic Laboratory their total area is 8 sq. ft. and at Chevy Chase 40 square feet.

About 2 cu. ft. sludge-room capacity was provided per person at the Hygienic Laboratory tank and 4 cu. ft. at the Chevy Chase tank. After providing the necessary settling-chamber and sludge-room capacities the total depth of the tank at the Hygienic Laboratory was 10 ft., and at Chevy Chase 12 feet.

No permanent sludge-pipe was provided. Instead it was decided that when sludge was to be removed an ordinary bilge or trench pump would be used. No special provision was made for the disposal of the sludge, as it was assumed that for most small plants shallow-trench disposal could be used.

One scum-board was provided at the influent-end and one at the effluent-end of the settling-chamber. The penetration below minimum water-level of the first scum-board was made 3 ft. because it was to serve also as one wall of the grease-chamber. The penetration of the effluent scum-board was made 2 ft., which was later found to be excessive. The tanks were provided with covers for safety, as a possible preventive of odors, and to keep the grease and scum from drying.

The function of the sand-bed is to satisfy as much as possible of the oxygen demand of the non-settleable organic substances in the sewage, and thereby to deliver an effluent which will not cause nuisance and which will remove part of the burden of possible water-purification plants. The function of the dosing-chamber is to control the manner of the application of the settled sewage upon the sand-bed in such a way as best to promote the activity of the oxidizing organisms.

The experimental sand-bed as designed for the Hygienic Laboratory plant consisted of a layer of sand 2 ft. deep and 7 by 12 ft. in area, resting upon a layer of gravel 6 in. deep. The effective size of the sand was 0.24 mm. The dosing-chamber was 3 ft. in diamenter and contained a 3-in. Miller sewage siphon. Each dose discharged a layer of sewage upon the sand-bed about 0.1 ft. in depth.

The average of solids in the raw sewage applied to the Hygienic Laboratory tank for three months was 1,000 parts per million. For the same period the average of solids in the tank-effluent was 330 parts per million. The solids removed by the tank were therefore 670 parts per million. The average of settleable solids in the tank effluent was 14 parts per million. Hence the total settleable solids in the raw sewage were 684 parts per million, and 98% of the settleable solids was removed by the tank.

The mean detention-period in the Hygienic Laboratory tank is five hours instead of six, as the flow has been somewhat higher than was expected. At Chevy Chase it is six hours. This is longer than is the custom with large tanks, but the effluent has practically never been septic and has had at all times the odor of fresh sewage. It seems likely, therefore, that where sewage is settled so close to the source as is usually the case with small tanks a main detention of five or six hours will not render it septic or foul-smelling.

Our experience thus far justifies the following tentative conclusions:

(1) It is possible by means of a five-hour detention period in a properly designed Imhoff tank to remove from the raw sewage of small communities 98% of the settleable solids without producing a nuisance.

(2) A mean detention period of six hours, based on the average daily flow, will not cause the sewage to become septic or foul-smelling if it is fresh when it enters the tank.

(3) The accumulation of a disagreeable mass of grease and fecal matters in the first compartment of the settling-chamber may be prevented by the introduction of a horizontal coarse-mesh screen at the water-level of this chamber. The screen keeps the floating matters submerged and apparently results in all fecal matter sooner or later becoming waterlogged and sinking through the slot into the sludge-chamber.

(4) It is too soon to state with conviction the amount of digested sludge that may be expected from small-scale tanks, but one tank indicates an apparent accumulation of 2.6 cu. ft. per year per person and another tank 4 cubic feet.

(5) The only time when tanks required daily attention was during the foaming-period, which lasted about 10 days, and during which time some of the foam had to be removed and buried. At all other times attention once a month at the most was ample.

(6) Since the foaming-period has been passed the scum-formation has been slight.

(7) The decomposed sludge obtained from the small-scale Imhoff tanks resembled that obtained in large tanks except that it had a higher moisture content. This may perhaps be explained by the shallowness of the sludge layer.

(8) A 15-in. sand-bed dosed with settled sewage at a net rate of 190,000 gal. per acre per day during the second summer reduced the average oxygen demand from 63 to 12 parts per million (24-hour at 20° C.). This is probably ample purification for many cases, but insufficient for others.

(9) The sand-bed required little attention during the summer months, but what would seem to be a prohibitive amount of attention during the winter months, even though covered with a tongue-and-groove wooden cover.

(10) No nuisance was produced during the summer months by the dosing of the uncovered sand-bed with the tank-effluent.

(11) The growth of weeds on the surface did not seem to have an unfavorable effect upon the operation of the sand-bed.

Gold dredges are rated as to capacity according to the amount of material the buckets can dig within a stated period. Some of the larger dredges working under favorable conditions handle 3000 cu. yd. per 24 hr. Some claim to be doing more than this.

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COST OF CONSTRUCTION OF A NARROW-GAUGE RAILROAD IN STANISLAUS COUNTY, CALIFORNIA

In a recent application to issue stock presented before the State Railroad Commission of California, the Patterson & Western Railroad Co. gives a statement of the cost of construction of its line. The road is a 36-in. gauge line, 23.6 miles long, running from the town of Patterson on the Southern Pacific Railroad to Jones Station. Eight miles of the line is laid with a 35-in. rail, and on the remainder of the road a 25-lb. rail is used.

The road was built in 1916 primarily to serve the Mineral Products Co. which owns and operates mineral-bearing property along the line. The road is, however, operated as a common carrier. The railroad company acquired the right-of-way but the terminals at both ends of the line are owned by the Mineral Products Company. The principal industries of the country traversed, besides mining, are stock-raising and agriculture.

The rolling-stock comprises two 18-ton Shay-geared locomotives, one 7-ton Milwaukee gasoline locomotive, fourteen 10-ton flat-cars, four 10-ton box-cars, ten ballast-cars, and a gasoline track-automobile. There are water-tanks, a fuel-station, and a telephone line. The first few miles is in the valley and the remainder of the line in rolling hills. The itemized cost of the road is as follows, no allowance being made for interest during construction:

Item	Total	Cost per mile	Total cost, %
Construction			
Grading	$63,064.70	$2,672.33	26.1
Bridges	9,435.76	399.82	3.9
Culverts	3,446.84	146.50	1.4
Trestles	3,388.32	143.57	1.4
Ties	11,134.18	471.78	4.7
Rails	47,195.47	1,999.85	19.5
Tracklaying and surfacing	17,481.37	740.73	7.2
Ballasting	3,723.65	157.74	1.5
Right-of-way fences	234.70	9.95	0.1
Small tools and other track material	8,374.73	354.88	3.5
Operating expenses during construction	4,309.97	182.62	1.8
Telephone line	1,522.99	64.52	0.7
Crossings and signs	259.55	10.98	0.1
Signals	14.82	0.63	..
Total construction	173,585.05	7,355.90	71.9
Buildings			
Stations and office building	1,044.26	44.25	0.4
Shop and engine-house	731.68	31.03	0.3
Roadway buildings	74.91	3.18	..
Fuel-stations	1,090.16	46.19	0.5
Water stations	893.76	37.87	0.4
Total buildings	3,834.77	162.52	1.6
Rolling-Stock			
Gasoline locomotives	3,340.89	141.56	1.4
Steam-locomotives	10,832.39	459.00	4.5
Freight-cars	12,050.06	501.59	5.0
Total rolling-stock	26,123.34	1,102.15	10.9
Overhead Expense			
Engineering	17,036.82	721.90	7.0
Right-of-way	3,184.94	134.96	1.3
Organization expense	501.48	21.25	0.2
General officers and clerks	10,957.53	464.30	4.5
Stationary and printing	886.46	37.56	0.4
Legal	501.75	21.26	0.2
Other general expenses	1,912.25	81.20	0.8
Taxes	721.93	30.59	0.3
Total overhead, including, engineering, general, legal, right-of-way, and taxes	35,703.16	1,513.02	14.7
Miscellaneous			
Unapplied construction material	1,005.39	42.60	0.4
Roadway machines	1,160.23	49.16	0.5
Shop and machine tools	4.25	0.18	...
Total miscellaneous	2,169.87	91.94	0.9
Grand total	$241,518.19	$10,225.53	100.00

COST OF REINFORCED CONCRETE BUILDINGS

In an address recently delivered before the Cincinnati Real Estate Exchange, W. P. Anderson, president of the Ferro-Concrete Construction Co., gave some data regarding the cost of construction of reinforced concrete buildings. Assuming a plain structure without fancy interior and not including excavation, heating, lighting, or elevators, all of which items vary considerably with the individual building, but including walls, windows, floors, floor-finish, stairs, toilets, and plumbing-fixtures, and assuming loads of 150 lb. per sq. ft. on the floors with columns 18 ft. centres, and story-heights about 12 ft., the base cost per story of a building 50 ft. square would be approximately $1.55 per sq. ft. If the building is 50 by 100 ft., this would be reduced to $1.20, if 50 by 150 ft. to $1.12, and if 50 by 200 ft. to $1.07. This is assuming a building from four to ten stories high. A three-story building would cost slightly more. A two-story building would cost from 8 to 12% more, and a one-story building from 15 to 20% more. Decreasing the width of the building from 50 to 25 ft. would increase the unit cost from 35 to 45%. Similarly, increasing the width would decrease the unit cost.

Increasing the live load from 150 to 300 lb. per sq. ft. in a six-story building would increase the unit cost. 25%. Decreasing the live load to 75 lb. would give a corresponding decrease in unit cost. Varying the column-spacing makes little difference in the unit cost. The cost when columns are spaced 15 ft. centre to centre both ways is only 6% greater than when the columns are spaced 25 ft. centre to centre.

Plain steel-sash windows cost about as much as the same area of plain wall, so that varying the number of windows has little effect on cost provided plain windows are used. Wire-glass windows are more expensive. The figures given above include only a minimum amount of interior partition-work around stairs and elevator-shafts.

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Recent Bids on California State Highway Work

Following is a summary of unit bids received by the California State Highway Commission on May 14 and 28, and June 4. Lump-sum bids were also received on two contracts, namely three bridges in Shasta county and an undergrade railroad crossing near Davis. The figures in parenthesis indicate the following contractors:

(1) Bechtel, Quayle & Fontaine, 625 Market street, San Francisco.
(2) Erickson & Peterson, Inc., Monadnock Bdg., San Francisco.
(3) C. H. and A. W. Gorrill, Call Bdg., San Francisco.
(4) Palmer & McBryde, 503 Market street, San Francisco.
(5) Tieslau Bros., San Francisco.
(6) Whitlock & Gorrill, Monadnock Bdg., San Francisco.
(7) Bates, Borland & Ayer, Oakland Bank of Savings Bdg., Oakland.
(8) P. H. Hoare, Bacon Bdg., Oakland.
(9) T. M. Olney, 358 Vernon avenue, Oakland.
(10) Western Construction Co., Oakland.
(11) George S. Benson & Sons, Stimson Bdg., Los Angeles.
(12) Conner Contracting Co., Higgins Bdg., Los Angeles.
(13) L. G. Garnsey, Central Bdg., Los Angeles.
(14) C. H. Hudson, Marsh-Strong Bdg., Los Angeles.
(15) M. R. Co., Inc., San Fernando Bdg., Los Angeles.
(16) Rogers Bros. Co., 408 South Spring street, Los Angeles.
(17) J. H. Shafer, 1640 Temple street, Los Angeles.
(18) M. T. Shafer, 220 West 33d street, Los Angeles.
(19) Robert Sherer, Pacific Electric Bdg., Los Angeles.
(20) Tryon & Brain, Merchants Trust Bdg., Los Angeles.
(21) James Fitzpatrick, Ochsner Bdg., Sacramento.
(22) Ira Hodson, San Luis Obispo.
(23) Sandercock Transfer Co., San Luis Obispo.
(24) W. J. Schmidt, Cedar and Sacramento streets, Berkeley.
(25) Connors, Green & Co., Eureka.
(26) Brashear-Burns Co., Hollywood.
(27) W. A. Kettlewell & Sons, Kingsburg.
(28) W. A. Dontanville, Salinas.
(29) M. Blumenkranz, Stockton.
(30) Harlan & Harlan, Williams.
(31) Engineer's estimate.

The following bids were received May 14 for construction of the highway from Santa Rita to Dublin, 3.2 miles, in Alameda county:

Item and quantity	(31)	(6)	(8)	(7)	(9)	(10)	(24)	(5)
Excavation, 24,000 cu. yd.	$0.60	$0.58	$0.525	$0.55	$0.65	$0.65	$0.65	$0.80
12-in. pipe, 40 ft.	0.50	0.60	0.40	0.50	0.50	1.50	0.55	0.75
15-in. pipe, 40 ft.	0.60	0.70	0.40	0.60	0.60	1.50	0.65	0.75
Concrete in culverts and monuments, 125 cu. yd.	10.00	12.00	11.00	10.00	14.00	9.00	11.00	14.00
Concrete in pavement, 4280 cu. yd.	3.25	5.00	3.28	3.15	3.50	3.40	3.55	5.40
Guard-rail, 5200 ft.	0.35	0.45	0.40	0.25	0.30	0.40	0.40	0.50
Monuments, 30	0.50	2.00	2.00	1.00	1.00	5.00	1.00	2.00
Total	$31,439.00	$39,272.00	$30,185.00	$29,306.00	$33,964.00	$33,627.00	$34.327.00	$46,782.00

The customary 15% for contingencies added to the engineers' estimate gives a total of $36,154.85. On this work the State will furnish pipe-railing, reinforcing steel, corrugated metal pipe, portland cement, sand, and coarse aggregate, valued at $20,937.90. Contract for the work was awarded to Bates, Borland & Ayer for $29,306, making the total estimated cost of the work, not counting the State Highway Commission's overhead, $50,243.90, or $15,700 per mile.

For the highway from Las Cruces to Gaviota Pass in Santa Barbara county, 2.9 miles, the following bids were received May 14:

Item and quantity	(31)	(19)	(13)	(21)	(25)	(23)	(12)	(14)	(2)	(22)
Excavation, 79,000 cu. yd.	$0.50	$0.54	$0.686	$0.70	$0.59	$0.57	$1.25	$0.62	$0.85	$0.525
12-in. pipe, 982 ft.	0.50	0.50	1.25	0.50	0.50	0.60	1.00	0.70	0.50	0.50
18-in. pipe, 687 ft.	0.55	0.50	1.50	0.60	0.60	0.75	1.00	0.80	0.55	0.70
24-in. pipe, 158 ft.	0.60	0.50	2.00	0.70	0.70	0.80	1.00	0.90	0.70	0.90
30-in. pipe, 96 ft.	0.70	0.50	2.50	0.85	0.80	0.85	1.00	1.00	0.90	1.20
36-in. pipe, 259 ft.	0.80	0.50	3.00	1.00	1.00	0.95	1.00	1.10	1.10	1.30
Concrete in culverts and monuments, 795 cu. yd.	11.80	10.85	15.75	12.50	12.00	10.50	13.00	12.00	11.50	12.50
Shale and gravel surfacing, 2900 cu. yd.	1.50	1.00	1.75	1.25	1.50	1.25	1.75	0.75	1.15	1.00
Guard-rail, 11,800 ft.	0.40	0.52	0.55	0.50	0.40	0.37	0.60	0.60	0.50	0.333
Monuments, 138	0.50	1.00	0.75	1.50	1.00	1.00	1.00	1.50	1.00	1.00

Adding 15% to the engineers' estimate gives $68,146.76. State will furnish pipe-railing, reinforcing steel, corrugated metal pipe, portland cement, sand, and coarse aggregate, valued at $10,920.40. Contract for the work was awarded to Ira Hodson for $59,949.83, making a total cost of $70,870.23, or $24,440 per mile. The cost for excavation alone was $14,300 per mile.

For the highway from Castaic to the Castaic school, 4.1 miles in Los Angeles county, the following unit bids were received:

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Item and quantity	(31)	(18)	(12)	(26)	(15)	(13)
Excavation, 23,100 cu. yd.	$0.40	$0.40	$0.50	$0.40	$0.52	$0.49
18-in. pipe, 520 ft.	0.45	0.60	1.00	1.50	0.60	1.50
12-in. pipe, 110 ft.	0.60	0.80	1.00	1.50	0.75	2.00
Concrete in culverts and monuments, 210 cu. yd.	12.50	14.00	12.00	8.00	15.00	16.75
Concrete in pavement, 3950 cu. yd.	4.20	6.19	4.75	3.69	4.50	5.965
Guard-rail, 2648 ft.	0.40	0.50	0.50	0.60	0.60	0.55
Monuments, 64	0.50	1.00	1.00	1.00	1.20	0.75
Total	$29,846.20	$43,500.50	$34,850.50	$28,093.30	$34,997.10	$40,902.65

Adding 15% to the engineers' estimate gives $34,323.13. The State will furnish pipe-railing, reinforcing steel, corrugated metal pipe, and portland cement, valued at $16,626.27. Contract was awarded to Brashear-Burns Co. for $28,093.30, making a total estimated cost of $44,719.57, or $10,900 per mile. It will be noted that the prices on concrete were lower than the estimate.

The following bids were received May 14 for construction of the highway in Solano county, near Cordelia. 3.46 miles:

Item and quantity	(31)	(28)	(8)	(6)	(30)
Excavation, 17,000 cu. yd.	$1.00	$0.85	$0.85	$0.70	$0.83
12-in. pipe, 40 ft.	0.50	0.60	0.60	0.60	0.25
15-in. pipe, 120 ft.	0.60	0.70	0.80	0.80	0.40
18-in. pipe, 185 ft.	0.80	0.80	1.00	1.00	0.75
Concrete in culverts and monuments, 85 cu. yd.	10.00	9.50	11.00	12.00	8.00
Concrete in pavement, 3500 cu. yd.	3.25	3.99	3.75	5.11	3.09
Wire-mesh reinforcement, 75,000 sq. ft.	0.001	0.005	0.02	0.005	0.001
Guard-rail, 4650 ft.	0.30	0.60	0.45	0.45	0.20
Monuments, 85	0.50	1.25	2.00	2.00	2.00
Totals	$30,977.50	$32,749.75	$32,577.50	$33,747.50	$26,976.75

Adding 15% to the engineers' estimate gives $35,624.13. The State will furnish pipe-railing, reinforcing-steel, wire-mesh reinforcement, corrugated metal pipe, portland cement, sand, and coarse aggregate, valued at $20,324. Contract for the work was awarded to Harlan & Harlan for $26,976.75, giving a total cost of $47,300.75, or $13,700 per mile.

On May 28, but one bid was received for constructing the highway from the Santa Clara river to Ventura in Ventura county, 4 miles, as follows:

Item and quantity	(31)	(12)
Excavation, 14,300 cu. yd.	$0.40	$0.50
18-in. pipe, 82 ft.	0.50	1.00
30-in. pipe, 26 ft.	1.00	1.00
Concrete in culverts and monuments, 115 cu. yd.	12.50	12.00
Concrete in pavement, 4080 cu. yd.	4.00	4.50
Guard-rail, 814 ft.	0.40	0.50
Monuments, 56	0.50	1.00
Total	$23,898.10	$27,461.00

Adding 15% to the engineers'estimate gives $27,482.82. The State will furnish pipe-railing, reinforcing steel, corrugated metal pipe, and portland cement, valued at $16,983.10. Contract for the work was awarded to the Conner Contracting Co. for $27,461, making the total cost, $44,444.10, or $11,100 per mile. The contract price was only $21.82 less than the estimate.

The following bids were received May 28 for construction of the highway from a point ¼ mile west of Visalia to Tulare, 9 miles, in Tulare county:

Item and quantity	(31)	(17)	(13)	(16)
Excavation, unclassified, 14,000 cu. yd.	$0.50	$0.55	$0.60	$0.70
Excavation, borrow, 4000 cu. yd.	0.65	0.55	0.78	0.70
12-in. pipe, 330 ft.	0.50	0.50	1.50	1.00
18-in. pipe, 30 ft.	0.60	0.75	1.75	1.00
24-in. pipe, 185 ft.	0.80	1.00	2.25	1.00
Concrete in culverts and monuments, 410 cu. yd.	10.00	11.00	16.00	12.00
Concrete in pavement, 9000 cu. yd.	3.00	3.44	4.89	4.66
Guard-rail, 700 ft.	0.50	0.70	0.40	0.70
Monuments, 44	0.50	0.75	0.75	2.00
Total	$41,403.00	$46,265.50	$63,366.75	$60,583.00

Adding 15% to the engineers' estimate gives $47,613.45. The State will furnish reinforcing steel, pipe-railing, corrugated metal pipe, portland cement, sand, and coarse aggregate, valued at $53,627.75. Contract for the work was awarded to J. H. Shafer for $46,265.50, giving a total cost of $99,893.25, or $11,100 per mile. This bid was also close to the estimate.

The following bids were received May 28 for construction of the highway from Zaca Station to Los Alamos, 9 miles, in Santa Barbara county:

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Item and quantity	(31)	(28)	(12)	(19)	(25)	(13)	(23)
Excavation, 60,000 cu. yd.	$0.40	$0.39	$0.50	$0.50	$0.46	$0.60	$0.45
12-in. pipe, 1125 ft.	0.45	0.40	0.50	0.50	0.50	1.50	0.45
18-in. pipe, 250 ft.	0.50	0.50	0.50	0.50	0.60	1.75	0.55
24-in. pipe, 280 ft.	0.55	0.60	0.75	0.50	0.75	2.25	0.70
30-in. pipe, 60 ft.	0.60	0.70	0.75	0.50	0.85	2.25	0.80
36-in. pipe, 380 ft.	0.70	0.80	1.00	0.50	0.95	2.25	0.85
Concrete in culverts and monuments, 480 cu. yd.	9.00	9.00	10.00	9.70	12.00	16.00	11.00
Concrete in pavement, 8540 cu. yd.	3.25	3.45	2.85	3.78	4.10	4.26	4.20
Wire-mesh reinforcement, 60,000 sq. ft.	0.001	0.0025	0.001	0.0015	0.005	0.01	0.002
Guard-rail, 10,000 ft.	0.40	0.45	0.40	0.54	0.45	0.40	0.375
Monuments, 162	0.50	1.00	1.00	1.25	1.00	0.75	1.00
Total	$61,303.25	$63,084.00	$64,683.50	$73,677.20	$74,670.50	$88,526.90	$73,390.75

Adding 15% to the engineers' estimate gives $70,498.74. The State will furnish reinforcing-steel, corrugated metal pipe, wire-mesh reinforcement, pipe-railing, portland cement, sand, and coarse aggregate, valued at $70,416.80. Contract for the work has been awarded to W. A. Dontanville for $63,084, giving a total cost of $143,500.80, or $15,950 per mile.

The following bids were received May 28 for construction of the highway from Batavia to Putah creek, 8.4 miles, in Solano county:

Item and quantity	(31)	(29)	(3)	(9)
Excavation, 21,100 cu. yd.	$0.70	$0.75	$0.45	$0.80
12-in. pipe, 160 ft.	0.40	0.75	0.50	0.50
18-in. pipe, 300 ft.	0.50	0.75	0.50	0.50
24-in. pipe, 60 ft.	0.60	1.25	0.70	0.70
Concrete in culverts and monuments, 200 cu. yd.	10.00	15.00	10.00	12.00
Concrete in pavement, 8200 cu. yd.	3.25	4.40	4.85	3.50
Wire-mesh reinforcement, 40,000 sq. ft.	0.001	0.015	0.0025	0.0025
Guard-rail, 450 ft.	0.30	0.75	0.40	0.35
Monuments, 52	0.50	1.50	1.50	1.00
Total	$43,871.00	$56,415.50	$51,925.00	$48,591.50

Adding 15% to the engineers'estimate gives $50,451.65. The State will furnish reinforcing-steel, wire-mesh reinforcement, corrugated-metal pipe, pipe-railing, portland cement, sand, and coarse aggregate, valued at $35,056.70. Contract for the work has been awarded to T. M. Olney for $48,591.50, giving a total cost of $83,648.20, or $9950 per mile.

The following bids were received June 4 for construction of the highway from Earlimart to Pixley, 5.9 miles, in Tulare county:

Item and quantity	(31)	(13)	(16)	(11)
Excavation, 13,400 cu. yd.	$0.50	$0.69	$0.70	$0.65
Moving and re-setting property-fences, 5465 lin. ft.	0.05	0.20	0.15	0.08
12-in pipe, 260 ft.	0.50	0.50	1.00	1.00
18-in pipe, 30 ft.	0.80	0.60	1.00	1.00
24-in pipe, 240 ft.	1.00	0.75	1.00	1.00
Concrete in culverts and monuments, 81 cu. yd.	10.00	16.00	16.00	15.00
Concrete in pavement, 5800 cu. yd.	3.00	4.80	4.90	4.00
Wire-mesh reinforcement, 1800 sq. ft.	0.001	0.001	0.05	0.01
Guard-rail, 200	0.50	0.60	1.00	0.80
Monuments	0.50	0.75	2.00	2.00
Total	$25,799.55	$39,955.55	$40,817.75	$34,352.20

Adding 15% to the engineers'estimate gives $29,669.48. The State will furnish pipe-railing, reinforcing steel, wire-mesh reinforcement, corrugated metal pipe, portland cement, sand, and coarse aggregate, valued at $33,340. Contract for the work was awarded to George S. Benson & Sons, for $34,352.20, giving a total cost of $67,692.20, or $11,500 per mile.

The following bids were received June 4 for construction of the highway in Tulare county from the southerly boundary to Earlimart, 6.6 miles:

Item and quantity	(31)	(15)	(27)	(13)	(16)	(11)
Excavation, 9900 cu. yd.	$0.50	$0.70	$0.75	$0.69	$0.70	$0.65
Moving and re-setting property-fences, 12,080 ft.	0.05	0.04	0.20	0.20	0.15	0.08
12-in. pipe, 900 ft.	0.50	1.00	0.75	0.50	1.00	1.00
24-in. pipe, 120 ft.	1.00	1.25	1.25	0.75	1.00	1.00
Concrete in culverts and monuments, 50 cu. yd.	10.00	12.50	14.00	16.00	16.00	15.00
Concrete in pavement, 6500 cu. yd.	3.00	3.90	4.25	4.40	4.95	4.00
Guard-rail, 48 ft.	0.50	1.00	1.00	0.60	1.00	0.80
Monuments, 53	0.50	1.50	1.50	0.75	2.00	2.00
Total	$26,174.50	$34,565.70	$39,118.50	$39,255.55	$42,891.00	$35,215.80

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Adding 15% to the engineers'estimate gives $30,-100.68. The State will furnish pipe-railing, reinforcing-steel, corrugated metal pipe, cement, sand, and coarse aggregate, valued at $37,673.50. Contract for the work was awarded to the M. R. Co., Inc., for $34,565.70, giving a total cost of $72,339.20, or $10,950 per mile. The principal variation from the cost was the cost of concrete.

The following bids were received for the construction of the highway in Shasta county from the northerly boundary to Hazel Creek, 11.2 miles:

Item and quantity	(31)	(19)	(4)	(25)	(1)	(21)	(7)
Excavation, 151,000 cu. yd.	$0.65	$0.79	$0.80	$0.737	$0.845	$1.00	$0.95
12-in. pipe, 2170 ft.	0.60	0.50	1.00	0.45	0.60	0.60	0.65
18-in. pipe, 1432 ft.	0.75	0.50	1.25	0.55	0.80	0.75	1.00
24-in. pipe, 1176 ft.	0.90	0.50	1.50	0.75	1.00	0.90	1.25
Concrete in culverts and monuments, 1200 cu. yd.	13.00	16.20	17.50	16.00	16.00	20.00	15.00
Concrete in retaining-walls, 60 cu. yd.	8.00	16.20	12.00	14.00	10.00	18.00	12.50
Rubble-masonry retaining-walls, 550 cu. yd.	4.50	8.00	8.00	6.00	9.00	10.00	5.00
Dry rubble-masonry retaining-walls, 290 cu. yd.	4.00	3.70	6.00	4.00	6.50	5.00	4.25
New property-fences, 3.2 miles	150.00	275.00	175.00	200.00	208.00	200.00	200.00
Moving and resetting property-fences, 2.7 miles	150.00	350.00	175.00	250.00	288.00	200.00	250.00
Monuments, 506	1.00	1.50	1.00	0.50	1.00	1.50	1.00
Total	$122,690.40	$150,148.00	$155,922.50	$140,001.10	$159,802.80	$188,403.40	$172,316.09

Adding 15% to the engineers'estimate gives $141,-098.96. The State will furnish pipe-railing, reinforcing-steel, corrugated metal pipe, portland cement, and material for new fences, valued at $14,859.94. Contract for the work was awarded to Conners-Green & Co. for $140,-001.10, giving a total cost of $154,861.04, or $13,800 per mile.

For the construction of the highway in Los Angeles county from Seeley's Ranch to a point near Acton, 10.6 miles, there was but one bid, that of Tryon & Brain, and this was rejected because too high. The detailed bid follows, the first figure being the engineers' estimate and the second the bid: excavation, $0.30, $0.30; 18-in. pipe, $0.50, $1.50; 24-in. pipe, $0.75, $1.75; concrete in culverts and monuments, $13.50, $15; concrete in pavement, $5, $7.36; guard-rail, $0.40, $0.55; and monuments, $0.50, $1.50. The total bid was $123,836.45. and the engineers' estimate, after making the 15% addition, was $102,-531.99. The State was to furnish pipe-railing, reinforcing-steel, corrugated metal pipe, and portland cement, valued at $54,069.59.

An examination of the above figures shows that in general, the only items that are of sufficient importance to make sure that the figures given in the bids are not arbitrary are the following: excavation, class A concrete in culverts and monuments, and class A concrete in pavements. In the case of excavation, the low bidder's figures ranged from $0.30 per cu. yd. for the work between Seeley's Ranch to a point near Acton, in Los Angeles, to $0.83 for the work near Cordelia in Solano county. Concrete in culverts and monuments where the State furnished all materials, ranged from $8 per cu. yd. for the work near Cordelia and the work near Castaic in Los Angeles county to $15 per cu. yd. for the work between Pixley and the Tulare County boundary. Concrete in pavement, the State furnishing materials, ranged from $3.09 per cu. yd. for the work near Cordelia to $4 for the work between Pixley and the Tulare County boundary, or from $0.038 to $0.05 per sq. ft. for 4-in. pavement. Where the State furnished cement only, the high and low limits for concrete in culverts and monuments were $15 and $12, respectively. For concrete in pavement, the corresponding figures were $4.50 and $7.36, or $0.056 to $0.091 per sq. ft. of 4-in. pavement.

A comparison with the bids on State highway work done in 1915 given in WESTERN ENGINEERING for September 1915 shows a range between $0.30 to $0.70 per cu. yd. for excavation. The prices on concrete in culverts and monuments where the State furnished all the materials ranged from $8.25 to $15. Where the State furnished the cement only, the range was between $7.50 and $16. The prices on concrete in pavement, the State furnishing all the materials ranged from $2.20 to $4.25, but there was only one bid exceeding $3.40. Where the State furnished the cement only, the range of price was from $3.49 to $6.15.

The cost per mile of concrete-paved highway, the pavement being 15 ft. wide, ranges from $10,000 to $12,000 per mile where the work is in the valleys so that the excavation is comparatively small. It should be remembered, however, that this is not the total cost, since the State Highway Commission's overhead is not included, nor the cost of right-of-way or of large bridges, which is borne by the county through which the highway passes.

Comparative fuel-values of gas and of crude-oil are discussed in the seventh annual report of the Los Angeles Department of Public Utilities. Tables are given for gas containing 900 B.t.u. and 1050 B.t.u. per 1000 cu. ft. The calorific value of a barrel of 14° Baumé oil is approximately equal to that of 7000 cu. ft. of 900 B.t.u. gas. For 25° Baumé oil, the equivalent amount of gas is 6500 cu. ft. The corresponding quantities for 1050 B.t.u. gas are 6050 and 5700. In these figures, no account is taken of more complete combustion when gas is used.

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TABLE OF DEPTHS AT ENTRANCE CHANNEL FOR THE PRINCIPAL PORTS OF THE WORLD

The accompanying table, showing present and proposed depths of channel was compiled for the Commission of Public Docks at Portland, Oregon. The authorities include Lloyd's Register, the Shipping World, and the records of the U. S. Hydrographic Office.

UNITED STATES.	Depth of Entrance Channel.		Project Depth
Atlantic Coast Ports.	High Water.	Low Water.	Low Water.
Portsmouth. N.H.	61	53	*
New York. N.Y.	45	40	40
Boston. Mass.	45	35	35
Baltimore. Md.	36	35	35
Newport News. Va.	38	35	35
Norfolk. Va.	38	35	35
Philadelphia. Pa.	35	30	35
Galveston. Tex.	32	30	30
New Orleans. La.	32	30	35
Pensacola. Fla.	32	30	30
Portland. Me.	39	30	30
Charleston. S.C.	33	28	28
Mobile. Ala.	29	27	27
New London. Conn.	29	26	*
Wilmington. N.C.	29	26	26
Savannah. Ga.	33	26	26
Houston. Tex.	25	25	25
Providence. R.I.	29	25	30
Brunswick. Ga.	29	23	23
Wilmington. Del.	27	21	21
Pacific Coast Ports.			
Seattle. Wash.	*	*	*
Tacoma. Wash.	*	*	*
Columbia Riv. Entr.	47	40	40
Los Angeles. Cal.	39	35	35
San Diego. Cal.	39	35	35
San Francisco. Cal.	37	33	*
Portland. Ore.	32	30	30
PANAMA CANAL.			
Panama.	61	45	
Canal.	45	45	
Colon.	41	40	
HAWAIIAN ISLANDS.			
Honolulu.	35	33	
PHILIPPINE ISLANDS.			
Manila.	36	32	
MEXICO.			
Acapulco.	†	†	
Manzanillo.	†	†	
Mazatlan.	Lighers used		
Tampico.	23	21	
Vera Cruz.	38	36	

CANADA	Depth of Entrance Channel.	
	High Water.	Low Water.
Esquimalt. B.C.	40	30
Halifax. N.S.	83	78
Montreal. Que.	32	32
Prince Rupert B.C.	46	36
Quebec. Que.	50	37
St Johns. N.B.	56	32
St Johns. N.F.	46	42
Vancouver. B.C.	42	35
Victoria. B.C.	40	30
ENGLAND.		
Barry Docks.	49	13
Barrow In Furness.	40	12
Blyth.	34	20
Bristol.	46	4
Cardiff.	42	6
Dover.	21	3
Falmouth.	58	42
Hartlepool.	31	20
Hull.	46	30
Liverpool.	59	32
London.	38	18
Manchester.	28	28
Middlesbrough.	37	20
New Castle On Tyne.	41	25
Portsmouth.	42	30
Southampton.	48	35
Plymouth.	42	30
Sunderland.	34	20
SCOTLAND.		
Aberdeen.	26	13
Dundee.	38	24
Leith. (Edinburgh)	30	14
Greenock.	32	21
Glasgow.	30	19
IRELAND.		
Belfast.	31	23
Cork (Queenstown)	29	17
Dublin.	33	20
SPAIN.		
Barcelona.	37	36
Bilboa.	27	18
Cadiz.	45	33
Carthagena.	32	32
Valencia.	28	27

GERMANY.	Depth of Entrance Channel.	
	High Water.	Low Water.
Bremen.	27	20
Bremerhaven.	40	28
Cruxhaven.	42	33
Danzig.	23	23
Emden.	34	23
Geestemunde.	40	28
Hamburg.	34	28
Kaiser Wilhelm Canal.	36	36
Konigsberg.	21	21
Kiel.	36	36
Lubeck.	29	29
Pillau.	22	22
Stettin.	23	23
Swinemunde.	23	23
Travemunde.	28	28
FRANCE		
Bayonne.	26	17
Bordeau.	25	11
Boulogne.	39	13
Brest.	45	25
Calais.	36	15
Cette.	24	24
Cherbourg.	53	36
Dieppe.	37	10
Dunkirk.	32	15
Havre.	44	22
La Rochelle.	19	3
Marseilles.	60	60
Nantes Canal.	20	20
Rochefort.	23	6
BELGIUM.		
Antwerp.	41	26
Ghent Canal.	29	29
Ostend.	32	16
Zeebrugge.	41	26
HOLLAND.		
Amsterdam.	32	32
Flushing.	41	26
Rotterdam.	35	30
DENMARK.		
Aarhuus.	24	22
Copenhagen.	31	31
NORWAY.		
Bergen.	†	†
Christiania.	†	†
Christianssand.	†	†

RUSSIA.	Depth of Entrance Channel.	
	High Water.	Low Water.
Archangel.	25	23
Cronstadt.	28	28
Libau.	27	27
Odessa.	30	30
Petrograd.	28	28
Riga.	25	25
Sebastopol.	†	†
Vladivostock.	†	†
ITALY.		
Brindisi.	32	32
Cagliari.	24	24
Catania.	50	50
Civita Vecchia.	25	25
Genoa.	52	52
Leghorn.	28	28
Messina.	59	59
Naples.	65	65
Palermo.	25	25
Savona.	30	30
Spezia.	26	26
Venice.	27	27
AUSTRIA.		
Fiume.	108	108
Trieste.	35	33
ROUMANA		
Constantza.	28	28
Sulina.	24	24
TURKEY.		
Constantinople.	†	†
Smyrna.	35	35
GREECE.		
Corinth Canal.	26	26
Piræus.	48	48
Salonica.	†	†
PORTUGAL.		
Leixoes (Oporto)	60	48
Lisbon.	53	41
SWEDEN.		
Gothenburg.	29	29
Malmo.	24	24
Stockholm.	30	30

AFRICA.	Depth of Entrance Channel.	
	High Water.	Low Water.
Alexandria. Egypt.	35	35
Algiers. Algeria.	†	†
Bizerta. Tunis.	46	46
Cape Town. Cape Col.	34	30
Durban. Port Natal.	42	36
Suez Canal. Egypt.	32	32
Tunis. Tunis.	24	21
CHINA, JAPAN, BRITISH INDIA, AND ORIENT.		
Bombay. India.	50	36
Calcutta. India.	43	32
Colombo. Ceylon.	36	33
Hong Kong. China.	47	42
Nagasaki. Japan.	92	84
Rangoon. Burma.	37	21
Shanghai. China.	30	21
Singapore. Str. S.	42	35
Yokohama. Japan.	39	34
AUSTRALIA AND NEW ZEALAND.		
Aukland. N.Z.	41	31
New Castle. N.S.W.	29	24
Port Adelaide. S.A.	41	33
Sidney. N.S.W.	45	40
SOUTH AMERICA.		
Bahia. Brazil	34	26
Buenos Aires. A.R.	32	30
Callao. Peru.	25	21
La Plata. A.R.	30	23
Maracaibo. Venez.	19	17
Montevideo. Urag.	29	27
Para. Brazil.	40	30
Pernambuca. "	25	18
Rio De Janeiro. "	†	†
Valparaiso. Chili.	†	†
WEST INDES, AND BERMUDA.		
Havana. Cuba.	41	39
San Juan. P.R.	40	38
Santiago. Cuba.	30	28
St. Thomas.	35	33
Bermuda.	24	20

* No Project • Over 100 Feet. † Over 50 Feet.

Authorities: Lloyds Register, Shipping World and U.S. Hydrographic Office Record.

TRACTORS IN THE UNITED STATES

The May Bulletin of the National Gas Engine Association contains data regarding 95 models of tractors, manufactured by 57 different companies, or about half of the companies making tractors in the United States. The list is, however, representative, and includes most of the larger concerns.

The horse-power rating of the various engines varies from 4 on the Beeman garden tractor to 93 on the 60-93 Twin City of the Minneapolis Steel & Machinery Co. The average is 31½ hp. As to number of cylinders, we find 6 'singles,' 24 'twos,' 64 'fours,' and 1 'six.' The smallest cylinder bore is 3 in., and the largest 10 in. The shortest stroke is 4 in. and the longest 15 inches.

One engine combines the smallest bore and the shortest stroke, and the largest bore and the longest stroke are also combined in one engine. Fifty-eight out of 95 engines are of the vertical type. The lowest engine speed is 335, and the highest 1200 r.p.m. Eighty-eight engines are fitted with high-tension ignition and the majority of these with magnetos.

The weight of the tractors varies from 400 pounds to 32,000. The list-prices range from $150 to $5400 f.o.b. factory.

Bessemer ore for making iron suitable for blowing to bessemer steel is one that will yield a grade of pig-iron containing not to exceed 0.10% phosphorus. While limits for the iron, silica, and sulphur-content are usuall assigned, the controlling factor is the phosphorus in the ore.

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METHOD OF TESTING THE SHUTTING-OFF OF WATER IN OIL-WELLS

The following suggestions have recently been issued by the California State Mining Bureau:

1. Measurements to the bottom of the hole and to the bottom of the casing-shoe must both be carefully checked before the casing is landed or cemented and before notifying the deputy supervisor of intention to test. A steel tape should be used in determining the distance that the sand-line or drilling-line measures over the derrick.

2. Casing must be tested by bailing the well to a safe depth, depending upon the collapsing-strength of the casing, before drilling below the shoe. Old casing may collapse with less pressure than that indicated for new casing. Testing by applying pump-pressure inside the casing will not always reveal leaks.

3. Drilling out the cement or other material in the casing must be done carefully to avoid damage to the 'shut-off.' The drill should be run only far enough to go through the cement and below the shoe. A distance of from five to ten feet below the shoe should be ample. Drilling too far below the shoe may cause complications that will prevent a positive test.

4. Bailing should, if possible, continue until all fluid is removed from the hole, unless there is danger of collapsing the casing. It is advisable to use the bailer until it brings up nothing but mud on the last 'run,' then to allow the well to stand an hour or more and again bail to remove water that has sprayed on the inside of the casing and drained to the bottom. When a well is in such condition that it cannot be bailed dry with safety, the fluid should be lowered to a certain depth by running the bailer to that depth until no more fluid is raised. A permanent target should be placed on the line to mark the bailing-point. If both oil and water are present in a well that cannot be bailed dry, it may be necessary to remove the water by bailing from the bottom of the well until the bailer fails to bring up water. The well should then be allowed to stand several hours and the bailer lowered to determine the point where it reaches water; at this point the well is ready for inspection by the deputy supervisor. Afterward the water may be removed by bailing from the bottom of the well, account being kept of the amount bailed out. It may be necessary to repeat this process several times in order to determine whether the water is being exhausted. In case of high pressure and flow of gas or in case of 'heaving' formation, it is probable that the well can be tested only by pumping.

5. When a tight or closed bailer is used in a deep well, some form of outlet or valve should be provided in order to relieve the pressure that may endanger the lives of persons in the derrick when the bailer comes out of the well. A leaky bailer should not be used in testing.

6. A well must stand at least twelve hours without any bailing before it is to be witnessed by a representative of the Bureau. A longer time is preferable.

7. The law requires that the Bureau be given written notice at least five days before a test. It will save time for both the operators and the State officials if additional notice of the exact time be given by telephone.

Engineers' Note Book

TABLE SHOWING CAPACITY OF OIL-WELL CASING AND TUBING

The following table, taken from the first annual report of the State Oil and Gas Supervisor of California, shows the capacity of casing and tubing per lineal foot. Thus, the capacity of 1500 ft. of 3-in. 8½-lb. tubing is 1500×0.372 gal. $= 558$ gal. or a little over 13 bbl. The capacity of 1200 ft. of 10-in. 45-lb. casing is $1200 \times 4.060 = 4872$ gal. or 116 barrels.

TABLE SHOWING CAPACITY OF TUBING AND CASING PER LINEAL FOOT IN GALLONS AND CUBIC FEET

Nominal inside diameter	Weight per foot, pounds	Actual outside diameter, inches	Actual inside diameter, inches	Capacity per foot Gal.	Cu. ft.
1¼-inch	2.24	1.660	1.390	0.079	0.0105
1½-inch	2.68	1.900	1.622	0.1078	0.0144
2 -inch	4.00	2.375	2.021	0.1661	0.0222
2 -inch	4.50	2.375	1.971	0.1582	0.0212
2½-inch	5.74	2.875	2.461	0.2470	0.0330
2½-inch	6.25	2.875	2.433	0.2420	0.0323
3 -inch	7.54	3.500	3.080	0.3870	0.0518
3 -inch	8.50	3.500	3.018	0.3720	0.0497
3 -inch	10.00	3.500	2.914	0.3460	0.0463
3½-inch	9.00	4.000	3.558	0.5160	0.0689
4 -inch	10.66	4.500	4.022	0.6600	0.0882
4 -inch	11.75	4.500	3.980	0.6510	0.0870
4¼-inch	16.00	4.750	4.082	0.680	0.091
4½-inch	12.85	5.000	4.506	0.830	0.116
4½-inch	15.00	5.000	4.424	0.799	0.107
5⅝-inch	20.00	6.000	5.352	1.170	0.156
6¼-inch	20.00	6.625	6.049	1.490	0.199
6¼-inch	24.00	6.625	5.921	1.430	0.191
6¼-inch	26.00	6.625	5.855	1.400	0.187
6¼-inch	28.00	6.625	5.791	1.365	0.182
6⅝-inch	20.00	7.000	6.456	1.700	0.227
6⅝-inch	26.00	7.000	6.276	1.610	0.215
6⅝-inch	28.00	7.000	6.214	1.580	0.211
6⅝-inch	30.00	7.000	6.154	1.546	0.206
7⅝-inch	26.00	8.000	7.386	2.224	0.296
8¼-inch	28.00	8.625	8.017	2.625	0.350
8¼-inch	32.00	8.625	7.921	2.560	0.343
8¼-inch	36.00	8.625	7.825	2.500	0.334
8¼-inch	38.00	8.625	7.775	2.470	0.330
8¼-inch	43.00	8.625	7.651	2.390	0.320
9⅝-inch	33.00	10.000	9.384	3.600	0.480
10 -inch	40.00	10.750	10.054	4.130	0.552
10 -inch	45.00	10.750	9.960	4.060	0.543
10 -inch	48.00	10.750	9.902	4.020	0.537
10 -inch	54.00	10.750	9.784	3.900	0.522
11⅝-inch	40.00	12.000	11.384	5.290	0.706
12½-inch	40.00	13.000	12.438	6.300	0.843
12½-inch	45.00	13.000	12.360	6.230	0.834
12½-inch	50.00	13.000	12.282	6.140	0.821
12½-inch	54.00	13.000	12.220	6.090	0.814
13½-inch	50.00	14.000	13.344	7.280	0.973
15½-inch	70.00	16.000	15.198	9.420	1.260

Book Reviews

RAILWAY ESTIMATES. By F. Lavis. Pp. 593. Ill., index. The McGraw-Hill Book Co., Inc., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $5.

A large amount of cost data on all branches of railroad construction derived both from recent technical literature and from the author's own wide experience in railroad construction at home and abroad, is given in the present volume. The first two chapters comprise a general discussion of railroad costs and estimates, and the succeeding chapters give a detailed discussion of costs and standard methods for all classes

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of railroad work from clearing and grubbing to buildings, shops, and yards, also rolling stock. The appendixes include a set of general specifications for railroad construction, an abstract of an appraisal of the Lehigh Valley Railroad made recently by W. J. Wilgus, a discussion of processes of timber preservation, and some general railway statistics. There are also some mathematical tables, including tables of level cuttings for both common and metric units. The book is well-illustrated and will be of value to those engaged in railroad surveys or construction, and also to those employed in valuation work.

HORIZONTAL CYLINDRICAL TANK GAUGING. By J. B. Morrow. Pp. 68. Ill. S. O. Spencer, Oakland, California. For sale by *Mining and Scientific Press*, San Francisco. Price, $10.

This is the most complete book on computing the contents of tank-cars, tank-wagons, etc., that we have seen. The relatively small number of engineers who are concerned with this class of computations will find the book of great value. Rule and tables are given for calculating the amount of liquid in filled and partly-filled horizontal tanks, with or without bulged heads, and of constant and varying diameters. Attention is also given to the special cases of tank-domes, seat-extensions on wagon-tanks, etc. The use of these diagrams should save a large amount of tiresome computation.

Industrial Progress

CONTROL FOR CRANE HOISTS

The General Electric Co. has perfected an automatic device that can be added to its standard type B drum-controller making a serviceable semi-magnetic dynamic braking control for crane-hoist service.

The additional equipment consists of a panel for wall-

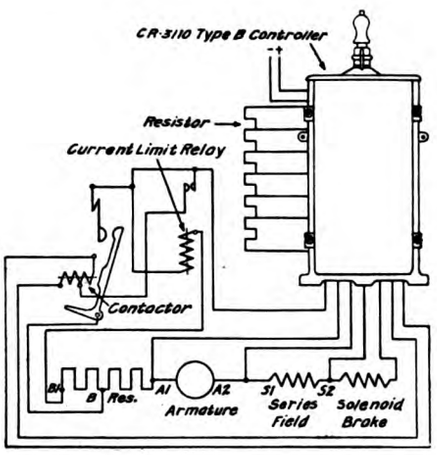

DIAGRAM OF HOIST-CONTROL

mounting which contains a direct-current contactor and current-limit relay and an extra resistance which is inserted in the circuit during the acceleration and deceleration period.

A dynamic-braking, manually-operated, drum-type controller is more severe on the commutator of a direct-current series-meter than is a plain reversing manual-controller, because, when lowering, the motor is connected similar to a shunt-wound motor and does not have the inherent protection of the series-field. Where the service is severe a semi-magnetic equipment will materially assist commutation. This equipment is useful also where the service is not quite severe enough to justify the expense of a full magnetic equipment.

The connections, when used with the dynamic-braking controller, are shown in the illustration. With this arrangement the resistance is so high that it is impossible to damage the motor no matter how quickly the controller is thrown on and off. The contactor and relay sumply insert and cut out this resistance when accelerating and decelerating in such a manner as to give practically the same speed-characteristics on the motor as would be obtained with a standard controller and at the same time prevent abusive currents.

PAINT FOR SMELTER-STACKS

The metal stacks of smelters are subjected to particularly severe conditions. Chemical activity increases rapidly at high temperatures and rusty smelter-stacks are a common sight. A durable paint is required to protect these surfaces from rust, as the cost of replacement is high. Oronite enamel paint has been successfully used by some of the large copper-smelting companies in Arizona and Nevada and has proved its worth.

Civil Service Examinations

GEOLOGIST PHILIPPINE SERVICE, July 10, 1917. Salary, $2500. Competitors will not be required to report for examination at any place, but will be rated on the following subjects, which will have the relative weights indicated:

Subjects	Weights
1. Education	40
2. Experience	40
3. Publications or thesis	20
Total	100

Graduation from a four years' course in a college or university of recognized standing, and in addition at least one year of postgraduate work in geology, and at least two years of executive experience in mining or practical geology, are prerequisites for consideration for this position. Under the third subject a thesis may be submitted in lieu of or in addition to publications. If such a thesis is submitted, it must present the results of the applicant's own investigational work on some geological subject. Applicants must not have reached their fortieth birthday on the date of the examination. The medical certificate in Form B. I. A. 2 should be executed by some medical officer in the service of the United States. Applicants should at once apply for Forms B. I. A. 2 and 2118, and these must be filed with the Commission at Washington prior to the hour of closing business on July 10.

ASSISTANT LAND CLASSIFIER, U. S. Geological Survey. Salary, $1500 to $1800. It is expected that from ten to fifteen appointments will be made in the near future. As insufficient eligibles were obtained from the examination of May 16 and 17, 1917, qualified persons are urged to enter this examination. Appointees will be assigned to the work of classification of lands in the public-land States, with special reference to dry farming, raising forage crops, stock-raising, grazing, their value for timber, and the possibility of their irrigation. The work will consist of field investigations and the writing and review of the resulting reports. The field of investigation will be in the more arid portions of the Western States, and in general the necessary office work will be accomplished in local Western offices of the survey. Competitors will not be required to report for examination at any place, but will be rated on the following subjects, which will have the relative weights indicated, on a scale of 100: (1) General education and training, 50; (2) Professional experience, 50. The applicant should set forth in detail his educational qualifications for the position. If the applicant has attended a college or university, he should submit a statement as to the course or courses pursued, together with a statement of the rating received on each subject, such statement to be signed by the proper officer of the college

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or university attended. The applicant will be required to show that he has a comprehensive knowledge of the fundamental principles of land classification and that he has had special training in one or more of the following lines of work:

1. Agronomy.
2. Animal husbandry.
3. Plant ecology.
4. Geology.
5. Irrigation and water-supply engineering.

The applicant must also show his ability to produce by the use of the plane-table and other instruments suitable land classification maps and reconnaissance topographic base. He must also show that he has had not less than twelve months of field experience in land classification work in the Western States, of which not less than three months must have been intensive classification. Until further notice and on account of the urgent needs of the service, applications will be received at any time. Applicants must have reached their twenty-fifth but not their fortieth birthday on the date of making oath to the application. Application form 1312.

Agriculturist for Reclamation Projects, July 10, 1917. Salary, $1800 to $2400. The duties of the appointees will be to work with individual farmers and farmers' organizations on the reclamation projects of Bellefourche, South Dakota, and Yuma, Arizona, to promote the development of live-stock industries. Competitors will not be required to report for examination at any place, but will be rated on the following scale of 100: (1) Education, 30; (2) Experience, 50; (3) Thesis or plan, 20. Graduation from an agricultural college, such training to have included specialization in animal husbandry or dairying, and at least three years' subsequent experience in practical farming or other agricultural work, are prerequisites for consideration for this position. Under the third subject the applicant must submit a thesis or plan of work dealing with the practical problems involved in the establishment of live-stock industries by a community of irrigation farmers and showing the relationship which a field man should have to this work. Applicants must have reached their twenty-fifth but not their forty-fifth birthday on the date of the examination. Application form 2118 must be filed with the commission at Washington prior to the hour of closing business on July 10.

Engineering Societies

Idaho Society of Engineers. Ira F. Schaffner, secretary, Boise.

Los Angeles Section of American Society of Mechanical Engineers. Ford W. Harris, secretary, 1029 Higgins building.

Los Angeles Section of American Institute of Electrical Engineers. Edward Woodbury, secretary, 255 East 3rd street.

Oregon Society of Engineers. Orrin E. Stanley, secretary, room 409, City Hall, Portland.

Portland Section, American Institute of Electrical Engineers. Paul Lebenbaum, secretary, 45 Union Depot.

Portland Association of Members of American Society of Civil Engineers. J. A. Currey, secretary, 194 North 13th street, Portland.

San Francisco Association of Members of American Society of Civil Engineers. E. T. Thurston, Jr., secretary, Mechanics Institute building.

San Francisco Section of American Society of Mechanical Engineers. Carl F. Braun, secretary, Hooker & Lent building.

San Francisco Section of American Institute of Electrical Engineers. A. G. Jones, 811 Rialto building.

Southern California Association of Members of American Society of Civil Engineers. Wilkie Woodard, secretary, 435 Consolidated Realty building, Los Angeles.

Utah Society of Engineers. Hugh C. Lewis, secretary, Capitol building, Salt Lake City, Utah.

At a meeting of the Oregon Society of Engineers held on June 8, O. P. M. Goss gave an address on lumber and its uses.

The regular meeting of the San Francisco Association of Members of the American Society of Civil Engineers was held on June 19. George W. Howson read a paper describing the dams of Sierra & San Francisco Power Co. on the Stanislaus river, particularly the Strawberry dam. The new amendments to the constitution of the Society affecting the local associations were discussed, and it was decided that the San Francisco association would be practically unaffected, except that the name would be changed to the San Francisco Section of the American Society of Civil Engineers.

Personal

Marvin Chase, of Wenatchee, has been appointed State hydraulic engineer of Washington.

Thomas Maddock has been appointed State engineer of Arizona succeeding Lamar Cobb, who resigned.

Captain C. E. Grunsky, Jr., has gone to San Diego, to take charge of the construction of the proposed army-cantonment at Linda Vista.

F. T. Robson has gone to Vancouver, Washington, with the other engineers who have been at the Reserve Officers' Training Camp at the Presidio, San Francisco.

Colonel W. H. Heuer has been re-appointed a member of the California Débris Commission. Colonel Heuer was a member of the commission for a number of years before his retirement in 1910.

W. L. McLaine, formerly superintendent for the Lost Hills Development Co., has gone to Caspar, Wyoming, to take charge of the operations of the General Petroleum Corporation in that region.

The following committee has been named to represent the portland cement industry before the Council of National Defense; John R. Morron, chairman, B. F. Affleck, George T. Cameron, Richard Hardy, E. M. Young, and J. P. Beck.

U. S. Marshall, formerly assistant engineer for the Sacramento County, California, Highway Commission, has been appointed senior highway engineer for the U. S. Office of Public Roads, with headquarters at Portland, Oregon. His district will comprise Oregon, Washington, Idaho, and Alaska.

Among those recommended for commissions in the Eighth Reserve Engineer Regiment are the following: Major, J. W. Williams, chief engineer for the Northwestern Pacific Railroad. Captains, Paul Reisinger, Clifton, Arizona; Morton Russell, Berkeley; Bert J. Simmons, Needles. First lieutenants, Harry L. Kile, Sacramento; Arthur T. Schunck, Berkeley; Donald E. Rhives, Ogden, Utah; and A. C. Howard, San Francisco. Second lieutenants, Thomas H. Darrow, Oakland, and John G. Howell, Los Angeles.

Commercial Paragraphs

The contracting firm of Ward & Goodwin, of San Francisco, have dissolved partnership by mutual consent.

At a meeting of the stockholders of both companies on June 13, the proposed merger of the Westinghouse Machine Co. and the Westinghouse Electric & Manufacturing Co. was unanimously ratified and the directors and officers of the two companies empowered to arrange for the merger.

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Western Engineering

WEEKLY NEWS BULLETIN

WESTERN ENGINEERING *with* WEEKLY NEWS BULLETIN
$4.50 per Year

SAN FRANCISCO, JULY 2, 1917

SINGLE COPIES WEEKLY NEWS BULLETIN
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Contracts Pending

Bids will be Received		See Issue of News Bulletin
July 2.	Ephrata, Wash., Road Work	July 2
July 2.	Fresno, Cal., Sewers	July 2
July 2.	Fresno, Cal., Street Work	July 2
July 2.	Goldendale, Wash., Street Work	July 2
July 2.	Oakland, Cal., Building	July 2
July 2.	Santa Ana, Cal., Supplies	July 2
July 2.	Vallejo, Cal., Building	July 2
July 3.	Bakersfield, Cal., Electric Lights	June 18
July 3.	Bakersfield, Cal., Machinery	June 18
July 3.	Chino, Cal., Machinery	June 25
July 3.	Mesa, Ariz., Machinery	June 25
July 3.	Mt. Vernon, Wash., Bridge	June 25
July 3.	Port Angeles, Wash., Road Work	July 2
July 3.	Pullman, Wash., Street Work	July 2
July 3.	Ritzville, Wash., Street Work	July 2
July 3.	Sacramento, Cal., Supplies	July 2
July 3.	Salt Lake City, Utah, Street Work	June 18
July 3.	Turlock, Cal., Street Work	July 2
July 3.	Washington, D. C., Machinery	June 18
July 3.	Washington, D. C., Machinery	July 2
July 3.	Yuba City, Cal., Building	June 11
July 5.	Oakland, Cal., Sewer	July 2
July 5.	Oakland, Cal., Street Work	July 2
July 5.	Oroville, Cal., Road Work	June 18
July 5.	Porterville, Cal., Building	July 2
July 5.	Portland, Ore., Building	July 2
July 5.	Riverside, Cal., Bridge	July 2
July 5.	Santa Barbara, Cal., Street Work	July 2
July 5.	Sonoma, Cal., Bridge	June 25
July 5.	Ventura, Cal., Road Work	June 25
July 5.	Visalia, Cal., Building	July 2
July 6.	Eagle Rock, Cal., Building	June 25
July 6.	Grants Pass, Ore., Road Work	July 2
July 6.	Miles City, Mont., Machinery and Supplies	June 25
July 6.	Salem, Ore., Bridge	July 2
July 6.	South Bend, Wash., Bridges	June 18
July 6.	South Bend, Wash., Road Work	June 18
July 6.	Vancouver, Wash., Road Work	June 11
July 6.	Visalia, Cal., Road Work	June 25
July 6.	Washington, D. C., Supplies	June 25
July 7.	Olympia, Wash., Buildings	July 2
July 8.	Eureka, Cal., Street Work	July 2
July 9.	Olympia, Wash., Bridge	June 25
July 9.	Ukiah, Cal., Road Work	June 25
July 9.	Yuba City, Cal., Road Work	June 25
July 10.	Eureka, Cal., Road Work	July 2
July 10.	Modesto, Cal., Bridges	June 25
July 10.	Red Bluff, Cal., Bridges	June 25
July 10.	Red Bluff, Cal., Supplies	June 25
July 10.	Stockton, Cal., Sewer	July 2
July 10.	Tracy, Cal., Machinery	June 25
July 11.	Washington, D. C., Supplies	July 2
July 12.	Fairfax, Cal., Building	July 2
July 12.	Oakland, Cal., Street Work	July 2
July 13.	Palo Alto, Cal., Building	July 2
July 13.	Walla Walla, Wash., Road Work	July 2
July 14.	Waterford, Cal., Supplies	June 25
July 16.	Canyon City, Ore., Irrigation	July 2
July 16.	Colfax, Wash., Bridge	July 2
July 16.	Everett, Wash., Road Work	July 2
July 16.	Lake Shore, Utah, Drainage	July 2
July 16.	Martinez, Cal., Road Work	June 25
July 16.	Sacramento, Cal, Road Work	June 18
July 16.	Seattle, Wash., Road Work	July 2
July 16.	Sonora, Cal., Miscellaneous	July 2
July 16.	Yuba City, Cal., Street Work	July 2
July 17.	Santa Ana, Cal., Bridge	July 2
July 17.	Seattle, Wash., Road Work	July 2
July 18.	St. Ignatius, Mont., Irrigation	July 2
July 20.	Seattle, Wash., Power	July 2
July 23.	Wells, Nev., Building	July 2
July 25.	Boise, Ida., Road Work	June 25
July 28.	Anderson, Cal., Building	July 2
July 28.	Waterford, Cal., Irrigation	June 25
Sept. 22.	San Francisco, Cal., River Work	July 2

Building Permits

In SAN FRANCISCO; $2500 and over in valuation.

JUNE 21

FOUR STORY BRICK RESIDENCE AND STORES—Cost $80,000. Perkins, McKinstry & Trowbridge, owners. NE Polk and Post.

TWO STORY BRICK PRIVATE GARAGE—Cost $7500. E. W. Newhall, Jr., owner. N Pacific Ave 66 E Baker.

TWO STORY FRAME APARTMENTS—Cost $7200. John Nagelmaker, owner. W San Bruno 62 N 25th.

ONE STORY FRAME RESIDENCE—Cost $2500. Annie McGuire, owner. S Quesada 450 E Newhall.

(Continued on Page 17)

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Construction News

STREET AND ROAD WORK

ACME, WASH.—Bond issue of $88,000 for construction of hard-surface road near Deming has been carried. The road will run from the U. S. bridge near Deming to the county line of Wickersham.

BELLINGHAM, WASH.—Riddle & Hawkins, Bellingham, have been awarded contract for paving Geneva road for $54,235. Charles A. Lindberry is county engineer.

COLFAX, WASH.—Whitman county commission has passed resolution to create an improvement district for construction of 23 miles of hard-surface road between Steptoe and Ewan. Estimated cost is $160,000. County engineer J. M. McCaw, Colfax, has charge of the work.

COLMA, CAL.—Contract for construction of sidewalks in Salem cemetery has been awarded to Fay Improvement Co., Phelan Bdg., San Francisco, for about $6000.

EL CENTRO, CAL.—No bids were received for paving part of Main street and work will be postponed for several months.

EPHRATA, WASH.—Bids will be received until July 2 by C. T. Sanders, county auditor, for surfacing 6½ miles of highway.

EUREKA, CAL.—Bids will be received until 5 p.m., July 8, by J. P. Wunderlich, city clerk, for grading several streets.

Bids will be received until July 10 by Fred M. Kay, county clerk, for surfacing six miles of highway with western road-a-lite or its equivalent.

EVERETT, WASH.—Bids will be received until July 16 by M. Weatherbee, county auditor, for hard-surfacing highways No. 26 and 29.

FRESNO, CAL.—Bids will be received until July 2 by W. H. Ryan, city clerk, for the following street work: grading, oiling, and construction of concrete curbs and corrugated culverts for eight blocks on Iowa avenue; grading and construction of concrete curbs and bitulithic pavement on crushed base on White's Bridge avenue; bitulithic pavement on concrete base and redwood curbs on alley in block No. 335.

Contract for improvement of Madison avenue has been awarded to Thompson Bros., Fresno, at 0.0225c. for grading and oiling, 30c. for concrete curbs, 10c. for concrete sidewalks, $2 per ft. for 24-in. corrugated culverts, and $1.90 per ft. for 18-in. culverts.

GOLDENDALE, WASH.—Bids will be received until July 2 by D. Gunning, city clerk, for construction of macadam pavement and wooden curbs on several streets.

GRANTS PASS, ORE.—Bids will be received until July 6 by E. L. Coburn, county clerk, for construction of part of Pacific highway.

LEMOORE, CAL.—Following bids were received for street improvements and electrolier lighting-system: Federal Construction Co., $140,941.17; California Road & Street Improvement Co., $146,562.74; Paul & Caldwell, $152,894.33; Thompson Bros., $155,516.20. All bids were rejected because too high and work will be re-advertised.

LOS ANGELES, CAL.—Contract for improving alley near Bonnie Brae street has been awarded to O. L. Stevens, 1933 Arapahoe street, Los Angeles, for $2897.74.

MANHATTAN BEACH, CAL.—Contract for street improvements has been awarded to R. H. Beaton, 623 Beacon street, San Pedro, for $54,569.40.

MARYSVILLE, CAL.—All bids for grading county highway near Nigger Jack slough have been rejected, and new call for bids will be issued.

MERCED, CAL.—Manning Bros., Fresno, were low bidders for paving several streets. The itemized bid was: 5-in. pavement, grading and surface, 14c. per sq. ft.; 4-in. pavement, grading and surface, 13c. per sq. ft.; branch culverts, $2; curbing, 47c. per lin. ft.; alley curbing, 25c. per lin. ft.; gutters, 15c. per sq. ft. Bids were taken under advisement until July 3.

All bids for street paving have been rejected because too high, and work will be postponed indefinitely. The lowest bid was from Manning Bros., Fresno, at $60,073, which was about $5000 more than the bid received two months ago, when a flaw in the proceedings prevented the award of the contract.

MODESTO, CAL.—A bond election for $90,000 for construction and improvement of several street connections and storm sewers will be held on July 31.

Election has been called for July 31 to vote on bond issue of $40,000 for paving street-intersections.

OAKLAND, CAL.—Bids will be received until noon, July 5, by L. W. Cummings, city clerk, for grading and construction of redwood curbs, concrete gutters and sidewalks, and oil-macadam pavement on East 23rd street.

Bids will be received until noon, July 12, by L. W. Cummings, city clerk, for construction of asphalt pavement on parts of 16th street.

OLYMPIA, WASH.—State Highway Commission has awarded contract for construction of part of Inland Empire highway to G. L. Stickler, Pullman, for $17,276.

PENDLETON, ORE.—Notice of intention to improve Ferry street has been published. Improvement will be 6-in. concrete base and 1½-in. asphaltic-wearing surface.

PORT ANGELES, WASH.—Bids will be received until July 3 by J. W. Warren, county auditor, for clearing, grubbing, and grading three miles of highway No. 7.

PORT ORCHARD, WASH.—Bids will be received until July 16 by J. M. Peterson, county clerk, for construction of permanent highway No. 1-C.

PULLMAN, WASH.—Bids will be received until July 3 by M. F. Cannon, city clerk, for construction of 7000 sq. yd. of bituminous macadam pavement on several streets.

REDWOOD CITY, CAL.—E. M. Chadbourne, 503 Market street, San Francisco, has been authorized to enter into private contracts for re-surfacing pavement on Broadway.

RICHMOND, CAL.—The following bids were received for paving Burbeck avenue: Sam C. Rogers, 401 Chanslor avenue, Richmond, $3990.52; L. L. Page, $4822.81; Walter K. Johnson & Frank Aguiar, $4160.40; G. W. Cushing, $4386.51; Frank Auzes & Frank Silver, $4685.37; Fred Meyer, $4208.92. Contract was awarded to Sam C. Rogers.

The following bids were received for paving Portola avenue: Walter K. Johnson & Frank Aguiar, $7281.50; Fred Meyers, $7885.59; S. C. Rogers, $8149.50; L. L. Page, $8311.50; G. W. Cushing, $8346.75. Contract was awarded to Johnson & Aguiar.

RITZVILLE, WASH.—Bids will be received until July 3 by J. C. Kittel, county clerk, for improvement of several streets.

SACRAMENTO, CAL.—The following details regarding the bids on state highway construction opened June 25 have been received:

In Tulare county between Tipton and Tulare, 8.9 miles, T. E. Shafer, Los Angeles, was low bidder at: excavation, $0.62 per cu. yd.; 12-in. corrugated pipe, $0.75 per ft.; 24-in. pipe, $1; 30-in. pipe, $1.50; concrete in culverts and monuments, $14 per cu. yd.; concrete in pavement, $3.92; guard-rail, $0.60 per ft.; monuments, $0.50 each; a total of $69,533.90. State will furnish materials valued at $51,880. Other bidders were: L. G. Garnsey, $72,855.95; M. T. Shafer, $74,617; L. S. Atkinson, $75,307; Johnson-Shea Co., $75,372. Engineers' estimate was $64,527.36.

In Monterey county between Camphora and Chualar, 11 miles, Palmer & McBryde, San Francisco, were low bidders at: excavation, $0.80; 12-in. pipe, $0.60; 18-in. pipe, $0.70; 24-in. pipe, $0.80; concrete in culverts and monuments, $15; concrete in pavement, $4; guard-rail, $0.50; monuments, $1; a total of $62,625. Tieslau Bros. bid $76,594.50. Engineers' estimate was $60,118.55. State will furnish materials valued at $61,092.68.

In Napa county between Napa and the easterly county boundary, 8.6 miles, Worswick Construction Co., Vallejo, was low bidder at: excavation, $1.05; 12-in. pipe, $0.45; 15-in. pipe, $0.55; 18-in. pipe, $0.67; 24-in. pipe, $0.80; 30-in. pipe, $1; concrete in culverts and monuments, $9.62; concrete in pavement, $4.43; wire-mesh reinforcement, $0.005 per sq. ft.; 4-in. tile drain, $0.18 per ft.; monuments, $2.30; a total of $92,437.20. Tieslau Bros. bid $97,259.50. Engineers' estimate was $86,-673.78. State will furnish materials valued at $72,016.

In Alameda county between Altamont and Greenville, 3.7 miles, Bates, Borland & Ayer, Oakland, were low bidders at: excavation, $0.66; 12-in., 15-in., 18-in., 24-in., and 30-in. pipe, $0.75 per ft.; concrete in culverts and monuments, $12.50; concrete in pavement, $3.80; guard-rail, $0.35; wire-mesh reinforcement, $0.01; monuments, $1.50; a total of $54,816.50. Other bidders were: Palmer & McBryde, $55,506; J. P. Holland, $59,901.30; P. H. Hoare, $67,515; C. H. and A. W. Gorrill, $72,671.50. Engineers' estimate was $57,522.31. State will furnish materials valued at $24,110.

In Tulare county between Tipton and Pixley, 6.4 miles, L. G. Garnsey, Los Angeles, was low bidder at: excavation, $0.70; moving property fences, $0.12 per ft.; 12-in. pipe, $1; 24-in. pipe, $1.25; concrete in culverts and monuments, $15; concrete in pavement, $3.59; guard-rail, $0.75; monuments, $1; a total of $34,980.50. Other bidders were: George S. Benson & Sons, $35,759.80; T. E. Shafer, $37,512.10; L. S. Atkinson,

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$39,309.80; Johnson-Shea Co., $39,608.50. Engineers' estimate was $32,818.81. State will furnish materials valued at $38,-221.50.

In Yolo county between Blacks and Hershey, 10.8 miles, C. H. and A. W. Gorrill, San Francisco, were low bidders at: excavation, $0.80; 12-in. pipe, $0.50; 18-in. pipe, $0.70; 24-in. pipe, $0.80; concrete in culverts and monuments, $12.50; concrete in pavement, $3.80; wire-mesh reinforcement, $0.0025; guard-rail, $0.45; monuments, $1.50; a total of $71,152.50. Other bidders were: Palmer & McBryde, $72,809; A. Teichert & Son, $74,837. Engineers' estimate was $66,308.33. State will furnish materials valued at $66,251.10.

De Witt & Rice bid $6992.50 for construction of part of H street road. Bid was taken under advisement.

Following are the quantities for the State highway work in Los Angeles county from a point near Acton to Palmdale, received until 2 p.m., July 16, by State Highway Commission: 66,100 cu. yd. excavation, 1514 ft. of 18 and 24-in. corrugated metal pipe, 290 cu. yd. concrete in culverts and monuments, 11,300 cu. yd. concrete in pavement, 7000 ft. of guard-rail, and 153 monuments. Plans at office of commission or at offices of division engineer in San Francisco and Los Angeles.

SALEM, ORE.—State Supreme Court has sustained Bean-Barrett bill, which provides for the issuance of bonds for the State's share of Federal road work outside of the $6,000,000 issue. This permits work under the $6,000,000 issue, independent of the Federal work.

SALT LAKE CITY, UTAH.—The State will co-operate with cities of Ogden and Logan in paving several streets.

Following were the low bids for street work received: paving extension of Ninth street south, J. W. Mellen, $55,704.34; paving Canyon road, P. J. Moran, $4089.67; sidewalks on 8th West street, Byberg Bros., $1375.35; sidewalks on California avenue, Ryberg Bros., $1021.63.

Bond issue of $1,500,000 for various municipal purposes including street improvements, extensions of water and sewer systems, bridges, etc., has been defeated by a large majority.

SAN BRUNO, CAL.—Following bids were received for street improvements: Municipal Improvement Co., Richmond, $119,-000; C. J. Lindgren, Burlingame, $120,000; Johnson-Shea Co., Oakland, $150,000. Bids were taken under advisement.

SAN FRANCISCO, CAL.—Contract for improvement of San Miguel and Mt. Vernon avenues has been awarded to T. A. Clark, 68 Post street, San Francisco, for $2021.

Contract for improvement of Minna street has been awarded to J. F. Dowling, Russ Bdg., San Francisco, for $2565.71; contract for improvement of Lane street has been awarded to H. Crummey, 332 19th street, Oakland, for $1708; contract for improvement of Farragut avenue has been awarded to Flinn & Treacy, First National Bank Bdg., San Francisco, for $909.75.

Contract for improvement of Persia street has been awarded to J. F. Dowling, Russ Bdg., San Francisco, for $707.

SANTA BARBARA, CAL.—Bids will be received until July 5 by A. C. Hall, city clerk, for construction of 5250 sq. ft. asphaltic pavement on concrete base on extension of Los Olivos street.

The city council has ordered street improvements to be made on De La Vina street between Montecito and Carrillo streets. Work will consist of concrete curbs and gutters, vitrified pipe sewer connections, and 4-in. concrete base and 2-in. asphaltic wearing-surface roadway. A. C. Hall is city clerk.

SEATTLE, WASH.—County commissioners will receive bids until July 17 for grading and graveling 2½ miles of permanent highway No. 2-F. Estimated cost is $50,000.

Bids will be received until July 16 by county commissioners for construction of permanent highway No. 11-B, comprising five miles of concrete pavement. Estimated cost is $20,000.

Contract for construction of Duwamish-Renton Junction highway has been awarded to Independent Asphalt Paving Co., Northern Bank Bdg., Seattle, for $71,296.

STOCKTON, CAL.—Contract for paving streets in southern part of city west of Sutter street has been awarded to Paul & Caldwell, Stockton, for $185,916.86. Contract for paving streets east of Sutter street has been awarded to Clark & Henery Construction Co. for $247,694.89.

Following bids were received for construction of pavement in Villa addition: Federal Construction Co., $44,181.67; Paul & Caldwell, $49,284.83; Clark & Henery Construction Co., $49,-847.37.

TULARE, CAL.—Plans have been completed for construction of 2.74 miles of concrete-base pavement, 20 ft. wide on streets connecting with state and county highways. Call for bids will be issued soon.

TURLOCK, CAL.—Bids will be received until 8 p.m., July 3, by A. P. Ferguson, city clerk, for construction of three blocks on bitulithic pavement on concrete base with concrete curbs on Third street.

WALLA WALLA, WASH.—Bids will be received until 2 p.m., July 13, at office of county engineer, Grova Cookerly, for construction of permanent highway No. 16. Plans and specifications on file at office of county engineer.

YUBA CITY, CAL.—Bids will be received until July 16 by Alvin Weis, county clerk, for construction of pavement in front of county buildings.

SEWERS AND DRAINAGE

ALAMEDA, CAL.—Contract for construction of 6-in. sewer on Bay street has been awarded to M. P. Cambar, 1044 91st avenue, East Oakland.

FRESNO, CAL.—Bids will be received until July 2 by W. H. Ryan, city clerk, for construction of 6 to 12-in. sewers in Arlington Heights district. Estimated cost is $30,000.

LAKE SHORE, UTAH.—Bids will be received until July 16 by Lake Shore & Benjamin drainage district for earthwork. Caldwell & Richards, Vermont Bdg., Salt Lake City, are engineers.

MARTINEZ, CAL.—Olmsted & Gillelen, Hollingsworth Bdg., Los Angeles, have completed plans for proposed sewer and water systems. Estimated cost is $200,000.

MODESTO, CAL.—Election has been called for July 31 to vote on bond issue of $45,000, $30,000 for storm-sewers and $15,000 for sanitary sewers.

OAKLAND, CAL.—Bids will be received until noon, July 5, by L. W. Cummings, city clerk, for construction of 8-in. sewer on Gaskill street.

RIVERSIDE, CAL.—Formation of drainage district containing 1000 acres west of city is proposed. C. N. Kirkpatrick is interested.

SALT LAKE CITY, UTAH.—Zerbe & Walker were low bidders at $2771.27, for construction of sewers on several streets.

STOCKTON, CAL.—Bids will be received until 10:30 a.m., July 10, by city clerk, George Pulich, for construction of sewer connections. Work includes use of 6 and 8-in. vitrified sewer pipe, 4-in. branch sewers, manholes, etc.

Following bids were received for construction of concrete sewer on Miner channel: John Heafy, Stockton, $45,840.59; Gorrill Bros., $50,305.32. Bids were rejected because too high, and will be re-advertised.

BRIDGES AND CULVERTS

COLFAX, WASH.—Bids will be received until July 16 by county engineer, J. M. McCaw, for the construction of a two-span concrete arch bridge over Union Flat creek near La Crosse.

OCEANSIDE, CAL.—It is proposed by the county supervisors to construct a concrete bridge over San Margarita river north of Oceanside at a cost of $40,000. The bridge will be built by the State and paid for by the county in four yearly installments.

OLYMPIA, WASH.—State Highway Commission has awarded contract for construction of Coweman River bridge to Monson Construction Co., Portland, for $18,427.

PORTERVILLE, CAL.—City engineer F. W. Pease has completed plans for reinforced concrete slab bridge over Porter slough. Estimated cost is $20,000.

RIVERSIDE, CAL.—Bids will be received until July 5 by A. B. Pilch, county clerk, for construction of West Riverside bridge. Estimated cost is $5000.

Contract for construction of Auburndale bridge has been awarded to Mercereau Bridge Co., Pacific Electric Bdg., Los Angeles, for $3827.44. Fred Peter bid $3960, and Munoz & Munoz, $4160.

SALEM, ORE.—Bids will be received until July 6 by county commissioners for construction of steel bridge over Willamette river. Estimated cost is $200,000.

SAN DIEGO, CAL.—Following bids were received for construction of concrete bridge on state highway at Pine Creek: Fred Steffgen, $9487; Holland Construction Co., $9790; W. F. Riley, $10,369; Frank Doran, $12,364; Macrae & Layaz, $12,-670; Munoz & Munoz, Los Angeles, $15,843; J. P. Hunter, Los Angeles, $17,800. All San Diego bidders except when otherwise noted. Two lowest bids were taken under advisement.

Following bids were received and taken under advisement for construction of wooden bridge over Viegas creek: Lincoln Johnson, San Diego, $3778; Fred Steffgen, $3797; Holland Construction Co., $4900; Munoz & Munoz, $5793.

SANTA ANA, CAL.—Bids will be received until 2 p.m., July 17, by W. B. Williams, county clerk, for construction of 440-ft. wooden bridge at Yorba Linda. County will furnish materials.

SEATTLE, WASH.—Contract for construction of frame-trestle bridge over Raging river was awarded to F. D. Van Vliet, 513 Hinckley boulevard, Seattle, for $1280.

Contract for construction of Duvall bridge has been awarded to Monson Construction Co., Portland, for $34,829, for steel construction.

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YUBA CITY, CAL.—Contract for construction of substructure for bridge across Feather river at Nicolaus has been awarded to Clinton Construction Co., 140 Townsend street, San Francisco, for $54,250. Other bidders were: Duncanson-Harrelson Co., $54,984; C. E. Cotton, $68,716; Ross Construction Co., $71,744; Jenkins & Wells, $73,840; Lake Bros., $78,500.

IRRIGATION AND WATER SUPPLY

CANYON CITY, ORE.—Bids will be received until July 16, by W. A. Pope, secretary Blue Mountain Ditch Co., for construction of one mile of ditch, 5 ft. wide on bottom.

MANTECA, CAL.—The timber flume at Hilts Sag on the canal of the South San Joaquin irrigation district will be replaced by a reinforced concrete trestle 70 ft. high and 2200 ft. long. Estimated cost is $150,000. This work will be spread over a period of four or five years in order to distribute the expenditure. A. Griffin, Manteca, is engineer for the district.

McMINNVILLE, ORE.—The Dennis Construction Co., McMinnville, has been awarded contract for $69,500 for construction of water system. Work includes construction of 10 miles of 12-in. water pipe lines, concrete diversion dam, and the furnishing of labor and materials.

MODESTO, CAL.—Election has been called for July 31 to vote on bond issue of $5000 for extension of municipal water system.

NORTH YAKIMA, WASH.—Election will be held on July 2 for vote by the Tieton land-owners on the proposition of forming an irrigation district. Election is to be held under the supervision of the Yakima county commission.

SAN FRANCISCO, CAL.—State Water Commission has received the following applications for permission to divert water:

H. I. Blakemore and Michael Welch, Lewiston, 10 second-feet in Trinity county for hydraulic mining. Plans include diversion-dam 20 ft. high and 60 ft. long, and two miles of ditch and flume.

W. E. Bradley, Standish, 1 second-foot for irrigation. Plans include 10-hp. gasoline engine and centrifugal pump.

City of Paso Robles, 5 second-feet from Salinas river for municipal purposes. Plans include pumping from bed of river. Estimated cost is $50,000.

SANTA BARBARA, CAL.—The bond issue of $590,000 for the completion of the Gibraltar dam on the Santa Ynez river has been carried by a big majority. The $85,000 bond issue for an outfall sewage system was carried by the same majority, while the $21,000 bond issue for improvement on the East boulevard failed to pass.

ST. IGNATIUS, MONT.—Bids will be received until 2 p.m., July 18, at the office of U. S. Reclamation Service, for construction of laterals on Flathead project, Montana, requiring 60,000 cu. yd. excavation, and 100,000 sq. ft. of concrete canal-lining. Work is from 7 to 12 miles north of Dixon, on the Northern Pacific Railway. Particulars from U. S. Reclamation Service, Washington, D. C., or St. Ignatius.

Plans and specifications for earthwork and canal lining on Flathead project, bids for which will be opened on July 18, at office of U. S. Reclamation Service, are now on file at office of 'Western Engineering.'

VALLEJO, CAL.—A 12-in. pipe-line from Rector canyon to the Napa State hospital is to be constructed by the state department to furnish additional water for the hospital.

YUMA, ARIZ.—Yuma Mesa Irrigation Co. has been formed to construct pumping plant on Colorado river and irrigate 17,000 acres of land. William Kryger, E. A. Freeman, and C. W. Ingham are interested.

LIGHT, HEAT, AND POWER

SEATTLE, WASH.—Bids will be received until July 20 by the Board of Public Works for a $3,000,000 power plant. Plans and specifications on file in the office of the Board of Public Works. Clarence Bagley is secretary.

RIVER AND HARBOR WORK

RICHMOND, CAL.—The following bids were received for 12,000 tons of rip-rap for the clay bulk-head in the inner harbor: Plate Bros., $2.73 per ton; Healy-Tibbitts Construction Co., $2.78 per ton; Daniel Contracting Co., $3.10 per ton. Bids were taken under advisement.

SAN FRANCISCO, CAL.—Clinton Construction Co., 140 Townsend street, San Francisco, was low bidder at $189.17 for reconstruction of pier No. 46.

Bureau of Foreign and Domestic Commerce, 306 Custom House, has information regarding river improvement work in Brazil, bids for which are to be opened on September 22. Estimated cost is $608,312. Refer to No. 24717.

RAILROAD WORK

SAN FRANCISCO, CAL.—Contract for construction of municpal railroad through Twin Peaks tunnel has been awarded to Eaton & Smith, 407 Eleventh street, for about $81,000.

BUILDING CONSTRUCTION

ANDERSON, CAL.—Election has been called for July 28 to vote on bond issue of $35,000 for construction of high-school building.

ASHLAND, ORE.—Bond issue of $70,000 for the erection of a high-school building has been carried.

BOWEN, MONT.—Grant, Smith & Co., Henry Bdg., Seattle, have been awarded contract for construction of engine-terminal to cost $300,000.

CUPERTINO, CAL.—Allison & Allison, Los Angeles, have been selected as architects for the proposed new school building. Bond election will be held about July 7.

FAIRFAX, CAL.—Bids will be received until July 12 by W. O. Miller, clerk of board of trustees, for construction of frame building on school grounds.

FORT JONES, CAL.—Contract for construction of school building has been awarded to William Potter, Fort Jones, for $12,890.

GLENDORA, CAL.—Allison & Allison, Los Angeles, are preparing plans for school building. Estimated cost is $30,000.

HEALDSBURG, CAL.—W. H. Weeks, 75 Post street, San Francisco, is preparing plans for school-building.

LOS ANGELES, CAL.—Contract for construction of class A building for L. A. Phillips has been awarded to J. C. Kubach Co., Merchants National Bank Bdg., Los Angeles, for $107,500.

MIDDLETOWN, CAL.—M. Crane was low bidder for construction of school building.

MODESTO, CAL.—The following bids were received for construction of Masonic Lodge building: L. G. Bergren & Son, San Francisco, $25,600; E. E. Etherton, San Francisco, $26,000; George Ullrich, Modesto, $26,527; A. N. Frost, Modesto, $27,550; W. A. Stevens, Modesto, $27,770; Ernest Green, Modesto, $29,600; Harvey A. Klyce, San Francisco, $29,985. All bids were rejected as being too high. Modifications will be made in specifications and new call for bids will be issued.

OAKLAND, CAL.—Bids will be received until 4:30 p.m., July 2, by D. W. Pratt, secretary Board of Education, for construction of building for Lakeview Annex school. Bids are being received by R. J. Pavert, 454 Wesley street, for construction of 3-story frame apartment house. Estimated cost is $35,000. Chas. J. Rousseau, 46 Kearny street, San Francisco, is architect.

Neilsen & Bergelsen were low bidders at $28,885 for construction of branch-library building.

OLYMPIA, WASH.—Bids will be received until July 7 by State Board of Control for construction of buildings at Norium. Estimated cost is $17,000.

PALO ALTO, CAL.—Board of Trustees of school district will receive bids until July 13 for construction of building for high school. Estimated cost is $200,000. Allison & Allison, Hibernian Bank Bdg., Los Angeles, are architects.

PENDLETON, ORE.—Parker & Banfield, Portland, have been awarded contract for $60,000 for construction of mausoleum in Pendleton cemetery.

PORTERVILLE, CAL.—Board of Education will receive bids until July 5 for construction of additional building for high school.

PORTLAND, ORE.—Bids will be received until 3 p.m., July 5, by R. H. Thomas, school clerk, Court House, for construction of brick building for Franklin high school.

SAN BERNARDINO, CAL.—Contract for construction of frame buildings at summer resort at Bear lake has been awarded to C. L. Robinson, Hibernian Bdg., Los Angeles, for $60,000.

SAN FRANCISCO, CAL.—Anderson & Ringrose, 320 Market street, San Francisco, were low bidders at $10,337 for construction of school building on Union street.

Contract for construction of addition to brick warehouse for Gale Estate has been awarded to G. P. W. Jensen, 310 Market street, San Francisco, for $20,000.

Contract for construction of two-story frame school building has been awarded to D. B. Farquharson for $40,308.

Clinton Construction Co., 140 Townsend street, San Francisco, bid $172,750, and L. G. Bergren & Son, 74 New Montgomery street, San Francisco, $175,472 for construction of reinforced concrete warehouse at Mare Island Navy Yard. These bids were taken under advisement and all other bids rejected.

F. H. Meyer, Bankers Investment Bdg., is preparing plans for construction of class C building for W. F. Perkins. Estimated cost is $70,000.

Contract for construction of coast-guard station No. 324 at

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Golden Gate has been awarded to Schroder Bros., 765 Folsom street, San Francisco, for $5800.

B. J. Joseph, Call Bdg., San Francisco, is preparing plans for alteration of store at 831 Market street. Estimated cost is $20,000.

SANTA BARBARA, CAL.—Contract for construction of garage for Bothin Real Estate Co. has been awarded to Parker Brick Co. for $15,175.

SANTA CLARA, CAL.—Contract for construction of reinforced concrete and brick warehouse for California Packing Corporation has been awarded to Trevia & Pasqualetti, 400 Bay street, San Francisco, for $21,850.

SANTA MONICA, CAL.—Kling Co., 15th street and Long Beach avenue, Los Angeles, was low bidder at $14,356 for construction of building for Carnegie library.

SEATTLE, WASH.—Contract for construction of building for Fauntleroy school has been awarded to Pohl Construction Co., 3406 37th avenue, South, for $47,203.

Contract for construction of apartment-house for Hamill & Ebright has been awarded to Northwest Construction Co., Seattle, for $45,000.

Contract for reconstruction of Moran school has been awarded to V. Stone & Lohmann, Securities Bdg., Seattle, for $20,200.

Contract for construction of ten warehouses for Earl Fruit Co. in various parts of Idaho and Washington, has been awarded to Hurley-Mason Co., Hoge Bdg., Seattle, for $500,000.

SOUTH SAN FRANCISCO, CAL.—Plans are being prepared by Geo. E. McCrea, First National Bank Bdg., San Francisco, for frame and concrete building for Fraternal Hall Assn., estimated cost being $18,000.

VISALIA, CAL.—Bids will be received until 10 a.m., July 5, by George H. Prestidge, county clerk, for making alteration in courthouse.

WELLS, NEV.—Bids will be received until July 22 by Board of Education for construction of addition to school building. Estimated cost is $13,000. Dickie & Donovan, Perry Bdg., Oakland, are architects.

YREKA, CAL.—Contract for construction of frame schoolbuilding in various parts of the county has been awarded to Barker & Nixon, Sisson, for $15,718.

MACHINERY AND SUPPLIES

OROVILLE, CAL.—Contract has been awarded to Dotson Pipe Co., Oroville, for furnishing 8000 ft. of cement pipe for use in the Orland irrigation project.

SACRAMENTO, CAL.—Bids will be received until 10 a.m., July 3, by M. J. Desmond, city clerk, for furnishing about 700 tons of 6 and 8-in. cast-iron pipe, with hydrants, valves, and other specials.

SAN FRANCISCO, CAL.—Bureau of Foreign and Domestic Commerce, 306 Custom House, has information regarding man in New Zealand that is in the market for seamless brass tubing and cold-rolled steel shafting. Refer to No. 24706.

The Bureau also has information regarding company in Chile that is in the market for telephone-equipment.

Contract for lighting fixtures for California theatre has been awarded to Thomas Day Co., 725 Mission street, San Francisco.

SANTA ANA, CAL.—Bids will be received until 2 p.m., July 2, by J. S. Perry, county purchasing agent, for furnishing lumber, piling, and reinforcing and structural steel for Yorba bridge.

VALLEJO, CAL.—Bids will be received until July 2 by commandant, Mare Island Navy Yard, for construction of a two-story frame building.

WASHINGTON, D. C.—Bids will be received until July 11 by Bureau of Soils, Department of Agriculture, for furnishing apparatus for evaporating brine and separating potassium and sodium chlorides at Summerland, Cal. Particulars from J. W. Turrentine, Arlington hotel, Santa Barbara, California.

Bureau of Supplies and Accounts, Navy Department, will receive bids until July 3 for furnishing three exhaust-blowers at Mare Island Navy Yard, Cal. Particulars from schedule 1259, which may be obtained from Purchasing Pay Officer, U. S. Navy Pay Office, San Francisco.

MISCELLANEOUS

ALAMEDA, CAL.—Henry Peterson will construct ship-building plants.

MARTINEZ, CAL.—Lacy Mfg. Co., Flood Bdg., San Francisco, has been awarded contract for construction of nine 55,000-bbl. oil-tanks for the Shell Co. of California.

OAKLAND, CAL.—Bids are being receiveed by Wm. H. Mallett, Major Coast Artillery, 14th and Mission streets, San Francisco, for construction of rifle-range at Leona Heights, including targets, pits, telephone system, and water system.

SAN FRANCISCO, CAL.—Contract for construction of retaining-wall at O'Farrell street and Van Ness avenue has been awarded to Barrett & Hilp, Sharon Bdg., San Francisco, for $5000.

Contract for construction of timber retaining-wall on Lower Cherry power-development, Hetch-Hetchy project, was awarded to F. B. Hill, 763 McAllister street, San Francisco.

A. H. Vogt, Sharon Bdg., San Francisco, was low bidder at $1600 for encasing steel water-tank at Fort Miley with concrete.

SANTA BARBARA, CAL.—Contract for construction of concrete-block fountain at Plaza del Mar has been awarded to Unit Brick & Tile Co. for $600.

SONORA, CAL.—Bids will be received until 2 p.m., July 16, by J. B. Doyle, county clerk, for fencing parts of state highway.

BUILDING PERMITS

(Continued from page 281)

TWO STORY FRAME CLUB HOUSE—Cost $35,000 Lake Side Golf Club, owner. Rancho Laguna de la Merced.

JUNE 23

ONE STORY FRAME WAREHOUSE—Cost $3000. Pacific Hardware & Steel Co., owner. N King 275 W 7th.

TEN STORY CLASS A OFFICES—Cost $600,000. American National Bank, owner. SE California and Montgomery.

JUNE 25

THREE STORY FRAME PRIVATE SCHOOL—Cost $45,000. Miss Burke, owner. SW Baker and Jackson.

THREE STORY FRAME RESIDENCE—Cost $11,600. Mrs. W. S. O'Brien, owner. S Jackson 165 E Buchanan.

JUNE 26

TWO STORY FRAME RESIDENCE—Cost $5000. Urban Realty Improvement Co., owner. W Desoto 103 S Urbano Drive.

TWO STORY FRAME RESIDENCE—Cost $5000. Urban Realty Improvement Co., owner. W. Desoto 153 S Urbano Drive.

TWO STORY FRAME RESIDENCE—Cost $3500. Urban Realty Improvement Co., owner. N Urbano Drive 131 W Victoria.

JUNE 27

TWO STORY FRAME DWELLING—Cost $5000. F. E. Lawson, owner. N Clifford 175 E Upper Terrace.

ONE STORY FRAME DWELLING—Cost $4000. Henry Clift, owner. S San Benito 100 W Santa Clara.

ONE STORY ADDITION FOR OFFICES—Cost $12,000. Uhl Bros., owners. S Market 195 W 4th.

JUNE 28

TWO STORY FRAME FLATS—Cost $4000. J. C. Kirby, owner. S Grove 25 E Shrader.

THREE STORY FRAME RESIDENCE—Cost $15,000. Bruce Fair, owner. N Green 34-2 E Lyon.

TWO STORY FRAME APARTMENTS—Cost $4950. Zupar & Kirby, owner. N Anza 32-6 E 5th Ave.

NOTICE OF SALE OF BONDS OF THE BAXTER CREEK IRRIGATION DISTRICT

The Board of Directors of the Baxter Creek Irrigation District having heretofore, as required by law, declared by resolution, duly entered upon its minutes, its intention to sell a specified amount of the bonds of said district, to-wit: bonds to the amount of $300,000.00, face value.

Notice is hereby given, that sealed proposals for the purchase of said bonds, will be received by the said board up to Two (2) o'clock P.M. on Tuesday, the 10th day of July, 1917, at its office at Lassen, Lassen County, California.

All bids shall be inclosed in a sealed envelope and addressed to the Secretary of the Board of Directors of the Baxter Creek Irrigation District, Lassen, California, and may be for all or any portion of said bonds.

At said time and place the board will open said bids and award the purchase of said bonds, or of a specific portion thereof, to the highest responsible bidder, provided, however, that they may reject any and all bids, or may accept bids for all or a portion only of said bonds.

Two Hundred and Sixty of the said bonds are each of the denomination of $1,000.000; Sixty-eight of said bonds are each of the denomination of $500.00; Twenty of said bonds are each of the denomination of $200.00; and Twenty of the said bonds are each of the denomination of $100.00, and commence to mature at the end of the twenty-first year from the date thereto, and all mature within twenty years thereafter, as provided in the act under which the district is organized.

Said bonds are dated July 1, 1917, and bear interest at the rate of six (6) per cent per annum, payable semi-annually.

Further information will on application be furnished by the Secretary of the Board of Directors.

By order of the Board of Directors of the Baxter Creek Irrigation District.

Dated, June 7, 1917.

J. B. CHRISTIE, President.
T. T. GROSS, Secretary

First publication, June 18, 1917.

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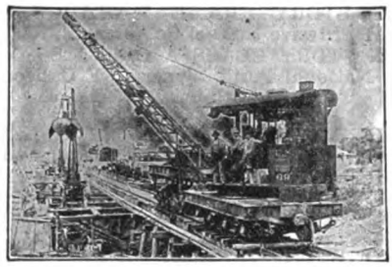

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1—Mead-Morrison Guy or Stiff-Legged Derrick, 10-ton capacity, 60-foot mast, 70-foot boom, complete.

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1—Westinghouse Motor, 30 h.p., 2200 volts, speed 850 R.P.M., with starter.

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